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**Project Pluto:
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missile**

**The day
Lindbergh
vanished**

**The war over
warbirds**



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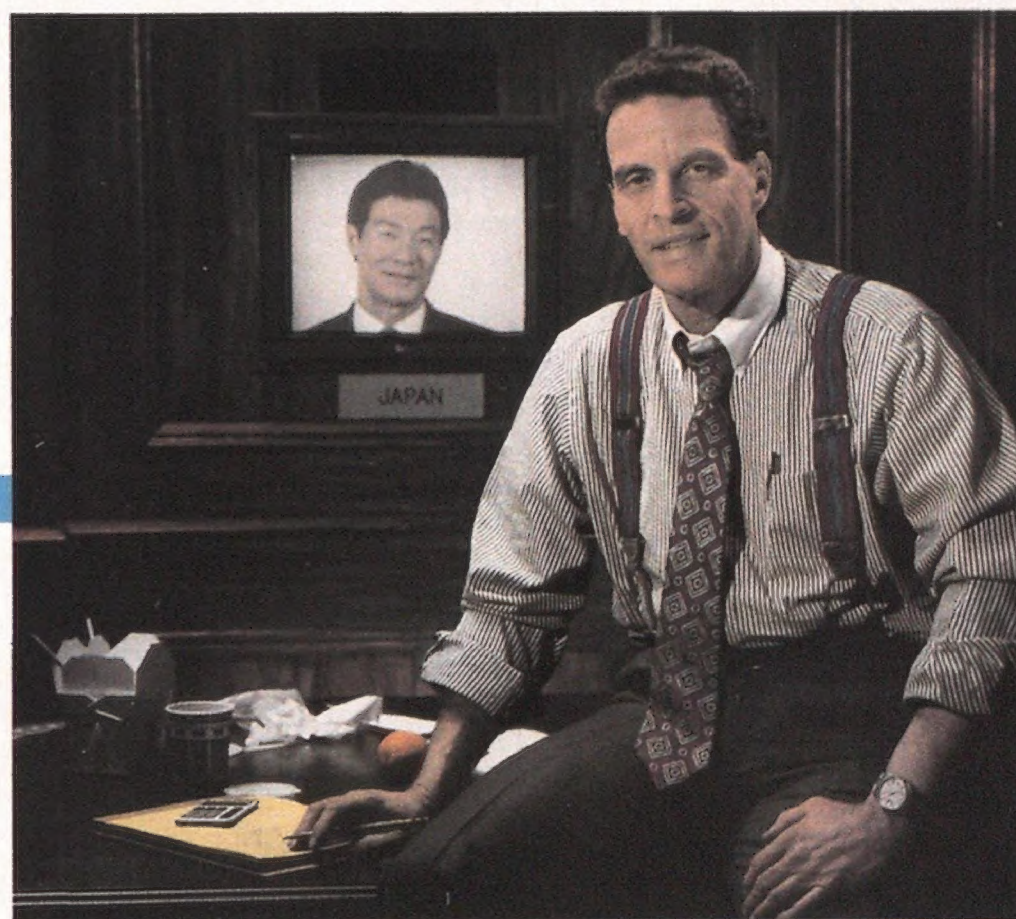


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Cover: Paul DiMare painted the projected result of Project Pluto.

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Are We Running Out of Wars?

In *The Outline of History*, H.G. Wells observed that "[a] man of foresight surveying the world in the early 16th century might well have concluded that it was only a matter of a few generations before the whole world became Mongolian—and probably Moslem." By 1529 the Turks were besieging Vienna, and it was not until the battle of Lepanto in 1571 that the tide appeared to turn.

This was the world into which Galileo was born in 1564. His early attempts to understand ballistics and his successful experiments to clarify the motion of projectiles were important to a generation preoccupied with throwing back the Ottoman armies that had been steadily advancing for three long centuries, becoming the most powerful empire of its day.

We tend to think that the link tying technological advances to military demands is a 20th century development. But the correlation between war and technical prowess is far more prevalent. Throughout history, fear of subjugation by a powerful enemy has facilitated the work of scientists and inventors.

I cannot imagine anything more removed from day-to-day military concerns than astronomical studies. Nevertheless, the most profound astrophysical discoveries since World War II have involved detection techniques initially developed for military surveillance and later made available for scientific purposes. As the Western world begins to realign itself politically this year, the interdependence of war and technology should be viewed with alarm. We have come to equate technological advances with progress, and progress with our American way of life. Consequently, we must now squarely ask ourselves whether the United States' standard of living may be permitted to depend on preparations for wars—hot or cold.

From a nation that has always abhorred war, the morally imperative response to that question must be a resounding "No!" But that will not solve the practical problems of maintaining our most successful high-technology industries at a

time when relations between the United States and the Soviet Union are improving. We must recognize that traditional wars are not likely to be our main threat in the years ahead. Instead, the damage we have inflicted on the environment poses far more serious challenges and potentially catastrophic problems for us and for generations to come.

To even assess the extent of the threat we will need to study global changes on land, in our waterways and oceans, and in the atmosphere. We have some idea of what that effort will take, because a succession of increasingly sophisticated Landsat satellites has been circling the globe since 1972. With the aid of powerful computers, images capable of highlighting vegetation of different kinds can be teased from the digital data gathered by these satellites over the years. The Center for Earth and Planetary Studies at the National Air and Space Museum has been one of many laboratories throughout the United States devoted to such studies. These show the Amazon Basin now undergoing extensive deforestation, especially in Brazil, where expanding populations have each year been clearing tracts of land comparable in size to Pennsylvania. And Central Europe is losing huge expanses of forested lands to airborne deposits from the burning of widely used sulfur-containing coal.

If we want to leave our children a green and blue planet, rather than a blackened desert, we will need to learn much more from sophisticated global surveys so that we can take effective measures to reverse the damage and save our planet's ability to support life. Landsat has been a good start in that direction. It will also take a massive effort on the scale of NASA's proposed Earth Observing System followed by energetic corrective action—challenges that will fully test our resourcefulness for decades to come. No other threats are needed to keep us inventive, productive, and alert. We need not worry about running out of wars.

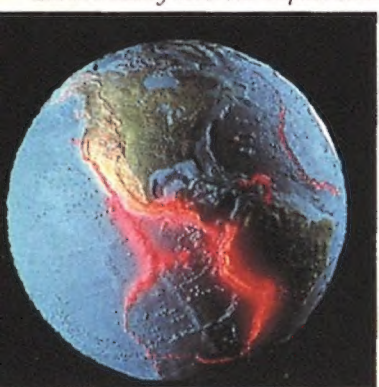
—Martin Harwit is the director of the National Air and Space Museum.



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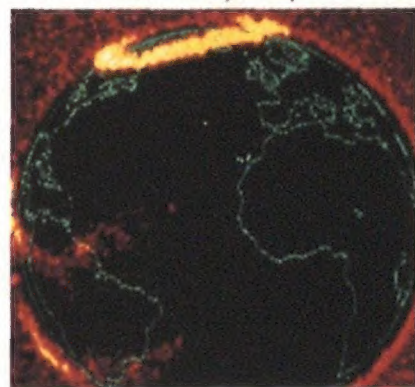
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Letters

A Closer Look

We give up. Even with the aid of an enlarging photocopy machine, a magnifying glass, and two pairs of experienced eyes, my wife and I could not determine what it says down the front of National Test Pilot School instructor Nadia Roberts' blouse ("Higher Learning," February/March 1990).

You will tell us, won't you?

Robert F. Hever
Columbia, Maryland

Editors' reply: According to Nadia Roberts, the message reads: "Plato, da Vinci, Joan of Arc, Einstein, Babe Ruth, James Brown and Me."

Autogiro Memories

Reading "The Autogiro and Its Legacy" (December 1989/January 1990) brought back memories of my time flying the autogiro.

I worked for Pacific Autogiro Sales in Santa Barbara, California, the company that purchased the autogiro that landed on the White House lawn. I was sent to the

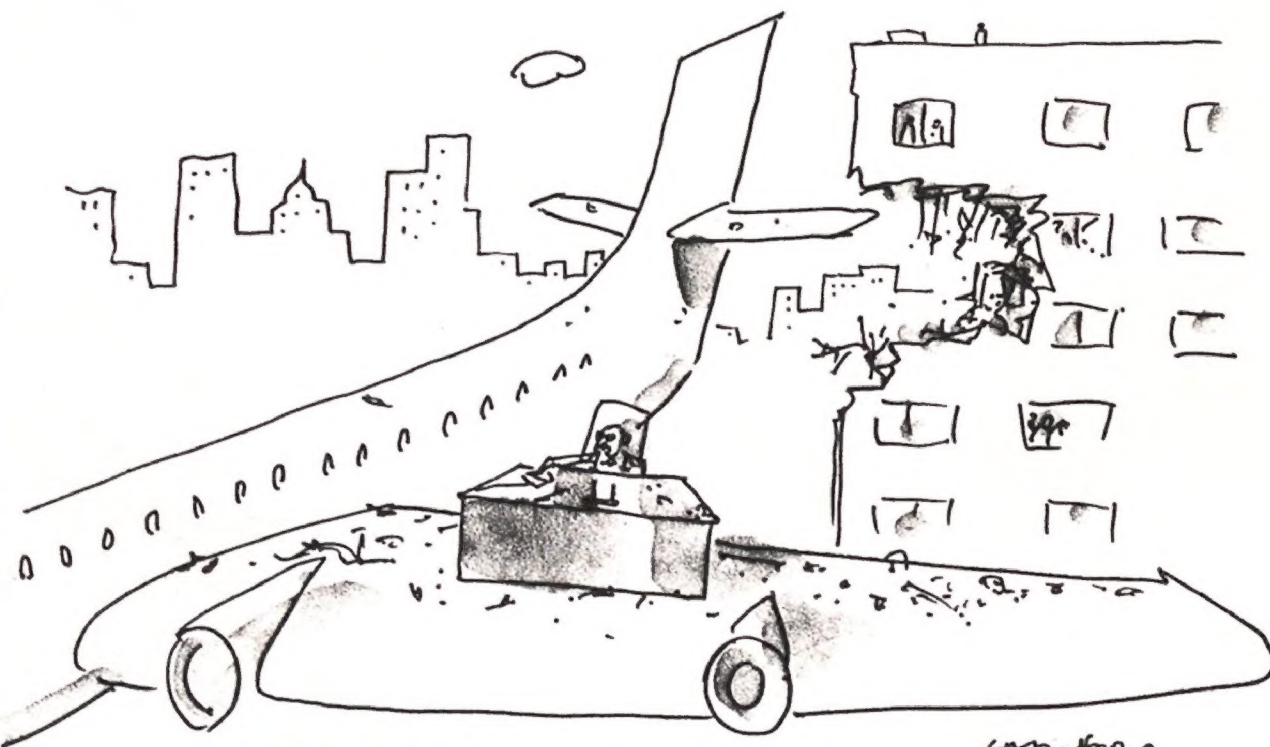
Pitcairn factory in Willow Grove, Pennsylvania, to learn to fly the autogiro. Afterwards I barnstormed with it through the western states in May and June 1932.

I had my share of problems flying autogiros. Once I landed in a muddy field, nosed over, and broke the rotor blades. Another time, while towing a campaign sign over Los Angeles, I banked too steeply in a turn and caught the rotors in the cable. It bent a rotor blade and broke the cable, and I had to make a forced landing in front of Olympic Stadium.

Hugo E. Bauhaus
Carpinterio, California

Please Come to Denver

I recently noticed in a local paper that the mayor of Denver proposed that the city's Stapleton airport be considered as a satellite site for the National Air and Space Museum. As a private pilot, taxpayer, and subscriber to *Air & Space*, I felt compelled to voice my opinion on the topic. I understand that there is a long standing policy of locating everything in Washington, but when the new Denver airport is completed, the Stapleton site would lend



Miss Brubaker, hold my calls.

canuto

itself very well to such a museum.

I would like to visit the National Air and Space Museum but have found it difficult to make a trip to Washington. If the NASM annex were located in Denver it would be convenient for all the airplane buffs in the Rocky Mountain region and on the West Coast as well. Please consider this proposal and come to Denver.

Thomas Lucas
Loveland, Colorado

Editors' note: On January 29, 1990, the Smithsonian Institution announced that the new annex for the National Air and Space Museum will be built at Washington's Dulles International Airport in Virginia. This site was chosen over others in Colorado and Maryland.

Zero!

"The Zero: One Step Beyond" by Steven L. Thompson (February/March 1990) implied that Lieutenant Commander Thach's famous weave maneuver defeated the Zeros at the Battle of Midway. History has credited his flight of six Wildcats with only six kills and one loss. This hardly accounts for the 332 aircraft Japan lost in the battle. The Douglas Dauntless dive-bomber was the aircraft responsible. It destroyed the four Japanese carriers, either catching the Zeros being serviced on the flight decks or sinking their landing fields and leaving the Pacific as the only alternate. The Zeros did destroy the majority of the 147 aircraft lost by the United States.

Ronald E. Jensen
Vancouver, Washington

Editors' reply: Thompson simply pointed out that the Thach Weave worked; he did not credit the tactic with winning the battle.

Steve Thompson really got my attention with his article. He probably will hear from other P-38, P-40, and F4U pilots because the statement on the cover that "until the Hellcat arrived, no other fighter could match it" isn't quite true. I think he intended to say that "no carrier-based fighter" was competition for the Zeke. Major Bong (P-38), Major McGuire (P-38), and Major Boyington (F4U) got 106 airplanes (mostly Zeros) between them in a very short time.

Thompson himself notes that fighter pilots flying inferior airplanes made them effective against the Zero with innovative tactics. Some examples were the Thach Weave, the way P-38s dove for quick strikes, Boyington's uncompromising

EYEWITNESS ACCOUNT: THE BATTLE OF BRITAIN



(Above) ADLERTAG, 15 AUGUST 1940. A limited edition fine art print from an original work by Frank Wootton, the RAF's official artist during World War II. Commemorating the valiant defense of Britain by the RAF and countersigned by six of the top scoring aces of The Battle of Britain. Partial proceeds will be donated to the Royal Air Forces Assn.

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discipline in the air, and Valencia's unorthodox maneuvers.

To further illuminate how Horikoshi's forward thinking dramatically changed the antiquated society in which he lived, a more complete explanation of the "carting" of the Prototype 12-shi from the factory to the airfield is necessary. This advanced fighter had to be carried to the field in pieces in ox-drawn carts over muddy roads.

There have only been a few great airplanes. The Zero was certainly one.

Hank Beaird
Reno, Nevada

Editors' reply: Thompson did not pen the cover lines; the editors did. However, the statement merely paraphrases what an Army evaluation had already concluded.

I read the excellent article on the Japanese Zero fighter and wholeheartedly agree with the parallels that are drawn to the present. However, I would like to take issue with Horikoshi's statement that "there has never existed anywhere in the world a fighter powered by a 1,000-hp air-cooled engine that was faster than the Zero, even without comparable range and dogfight characteristics."

There were at least two aircraft that bested the Zero in speed and did it with air-cooled engines of 750 hp. These were the Italian fighters S.A.I.207 and S.A.I.403 Dardo. Had the Italians not capitulated in 1943, these airplanes would have seen service in the Regia Aeronautica. For the record, the S.A.I. Dardo is listed as having a maximum speed of 403 mph at 23,620 feet and was reported to have outstanding handling characteristics.

John W. Suggs Jr.
Washington, Michigan

Editors' reply: It's too late to ask Horikoshi how he qualified the term "fighter," but it seems reasonable to assume that the phrase "in service" is implied.

Salyut Rescue II

As a postscript to your recent article describing the 1985 rescue of Salyut 7 ("The Rescue of Salyut 7," February/March 1990), the Soviets are now taking the first steps toward what may become the second rescue of Salyut 7 if Buran is not ready in time to recover it.

In mid-January 1990, Mir's orbit was boosted above that of Salyut 7 along the south Atlantic ground trace. Although not yet co-planar, Salyut 7's decaying orbit is falling through Mir's altitude. The orbit change narrows the difference between

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their orbital periods, postponing a co-planar orbit predicted for late 1990.

A co-planar orbit would complicate the rendezvous and separation maneuvers of Progress/Soyuz spacecraft as Mir overtakes an out-of-propellant Salyut 7/Cosmos 1686 space station complex.

Sam Ricks
Philadelphia, Pennsylvania

Comic Relief

"How Much Can You Carry?" (Soundings, February/March 1990), about the Watsonville aerial circus/relief expedition, provided much appreciated comic relief. If these heroes had loaded up their station wagons instead of their Cessnas they could have delivered three times the payload and saved an awful lot of fuel. But then it would have been hard to pretend that they were "Smilin' Jack," flying serum to the doomed polar expedition, and their long silk scarves might have very well become fouled in their stick shifts.

Ivan Kelley
Canyon Country, California

Who Started the Fire?

"Keepers of the Flame" by T.A. Heppenheimer (December 1989/January 1990) was quite interesting, but the article states, "There is still a dispute over who built the first scramjet." There should be no question who demonstrated supersonic combustion with hydrogen within a closed duct, simulating scramjet-type combustion. When this work was going on in the 1950s I was manager of combustion projects in the research division of the Marquardt Aircraft Company. In a classified program for the Air Force, my group demonstrated supersonic combustion in a closed duct in 1957. The pressure profiles produced matched the theoretical profiles with no shocking out of the combustion air stream. At the time this was so new that many people did not believe us. We had visits from many, including Dr. Avery and cohorts from Johns Hopkins University. As people began to realize the significance of our achievement, the scramjet evolved.

Warren Koffer
Los Altos, California

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Says Jetrivia creator and TWA pilot Richard Roberts, "Telling passengers what they're flying over makes the trip more interesting"—that is, if you're interested in the site of the Mason-Dixon Line's first marker (Salisbury, Maryland), the three-quarter-mile-wide hole punched in the southwest desert 25,000 years ago (Arizona's Meteor Crater), or the Trout Capital of the world (Buhl, Idaho).

Roberts started developing Jetrivia in 1984 when he was an executive at Ozark Air Lines. To make flights more memorable, he developed simple route

maps dotted with points of interest and encouraged Ozark captains to share them with passengers via in-flight announcements. After Ozark (and Roberts) were acquired by TWA, Roberts spent his spare time stockpiling information from state tourism offices. Last December he printed 10,000 Jetrivia maps and ran an ad in *USA Today*.

Though the ad drew a fair number of Christmas shoppers, Roberts expects airline employees to be his biggest customers. "When I was a flight attendant, we were constantly asked if we were flying over the Mississippi River," says Daniel Smith, also a former International Airline Passengers Association executive. "We didn't know where the heck we were—all we cared about was whether we had enough meals." With a set of three Jetrivia maps for \$9.95, however, crews can point out not only the Mississippi River but the National Elk Refuge (Jackson Hole, Wyoming) and the birthplace of Perry

Como (Canonsburg, Pennsylvania).

Still, some passengers couldn't care less. "I would just as soon that [the pilots] keep their mouths shut," says Larry Brown, a Los Angeles businessman who logged 100,000 air miles last year. "You usually can't see anything, and when you can, half the time you're on the wrong side of the plane."

—Preston Lerner

Student Drivers

For Roy Shaham, spring break at California State University's Northridge campus does not mean a week-long blowout at Palm Springs. It means getting in a little extra time to design an engine for a Mars scout.

Shaham, 23, is one of a group of 19 Northridge engineering students that has received a \$105,000 grant to come up with a lightweight unmanned aircraft to scout Mars. The grant for the three-year project was awarded last year by the Universities

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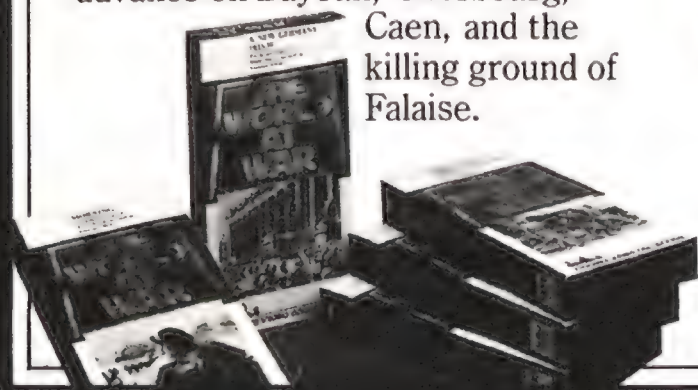
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A potentially bright comet will be visible in the moonless skies over North America in the last week of April and the first week of May. Discovered by New

Zealand amateur astronomer Rodney Austin last December, Comet Austin could rival Comet Bennett's 1970 performance. However, since the

disappointment that followed the abysmally dim Kohoutek in 1973, astronomers are reluctant to predict Austin's magnitude or tail length.

Space Research Association, which sponsors NASA-endorsed research.

NASA has projected a 1992 launch date for an orbiting Mars observer and hopes to send unmanned rovers by 2000 to retrieve soil samples, according to John Alred, a former long-range planner for the space agency who now manages the university program. The students' design and prototype, to be completed this June, will be considered for incorporation in a flying rover that may be sent along with the land vehicles.

For the scout's power source, which must function in Mars' carbon dioxide-rich atmosphere, the students considered and rejected nuclear power (too heavy), an engine capable of cracking carbon dioxide into oxygen and carbon monoxide (too time-consuming a process), and solar power combined with batteries (too cumbersome for a small vehicle). They eventually settled on hydrazine because "you get more bang for your buck," says Shaham, the propulsion manager. "The hydrazine undergoes a chemical decomposition, which transforms it into a gas that then produces very high temperatures. It's basically your average backyard lawnmower engine."

NASA has used hydrazine engines for unmanned research aircraft like the Mini-Sniffer, which in the 1970s explored Earth's atmosphere at 20,000 feet.

At a recent design review of the Northridge project, NASA aerospace engineer Robert Antoniewicz listened intently to proposals, then fired off questions: "How did you arrive at your lift calculations? Did you take into account Mars' reduced gravity? Would sandstorms be a problem?" Mission planning for the project "has proceeded beyond my expectations," he says. "We gave [the students] a wide latitude and very few restraints, which helps them get a fresh viewpoint."

Debate on the craft's design has covered expandable boom wings, hinged wings, tandem wings, telescoping wings, and even inflatable rotary wings. "It looks like it's going to be hinged wings—very thin to give plenty of lift in Mars' weak atmosphere," says vehicle design manager Dean Huebert.

The students are also considering which scientific instruments to stow on board. Recommendations include an electromagnetic sounder, capable of

detecting water to a depth of about a half-mile, and a magnetometer, a mapping device adept at detecting magnetic fields and studying the planet's tectonic history.

—R. Daniel Foster

Update

LDEF Relatively Unscathed

The Long-Duration Exposure Facility, retrieved by the shuttle Columbia last January, suffered only cosmetic damage during its six years in orbit ("What Goes Up . . .," August/September 1989). Though pitted by micro-meteoroids and space debris, darkened by ultraviolet radiation, and eroded by atomic oxygen, LDEF, according to its data analysis team, could be cleaned up and returned to orbit with another load of experiments.

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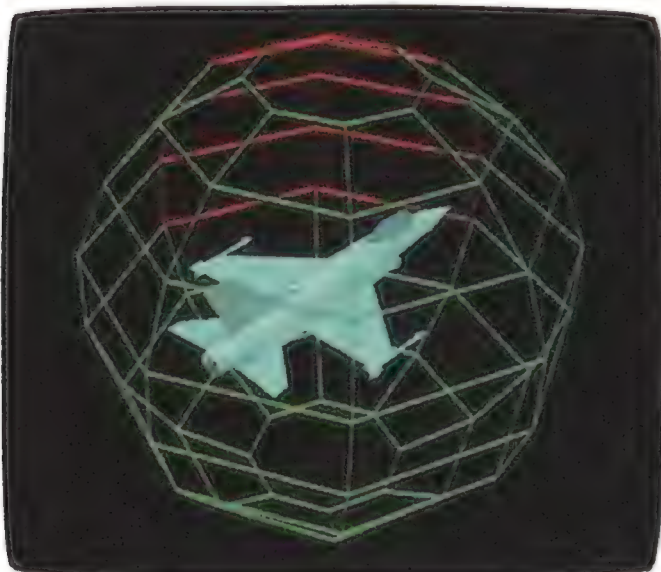
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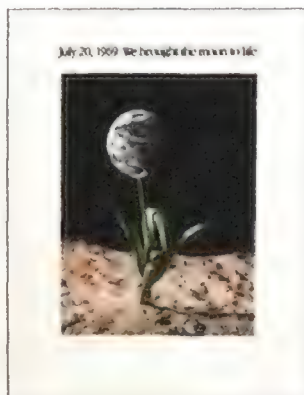
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Shooting the Breeze

An odd thing happened to the flat-water sport of wind surfing back in the late 1970s. A group of adventurous young sailors in Hawaii began sailing their boards up the faces of peaking waves and launching themselves off the top, rocketing as much as 25 feet into the air as the waves dropped out from beneath them. Unfortunately, the minute the board left the water, it began a losing battle with aerodynamics as board, sail, and sailor crashed back into the sea from dizzying heights.

While the members of the Maui Air Force, as the hot new breed of wind surfers called themselves, worked on their landings, two young men on the Eastern Seaboard took a more scientific approach. Tom Magruder was a wind surfer; Robert Crowell, a hang glider. They decided to combine the two sports and develop a rig that would allow the sailor to really fly.

The first Magruder-Crowell design was a rigid sail anchored by support wires to a short mast on the board. A universal joint allowed the sail to be rotated horizontally over the sailor's head, turning it into a wing once the contraption was airborne. Unfortunately, they forgot to plug the end of the mast tube, and the rig sank the minute it took on water. When they solved that problem they found that once Magruder got the thing going he lost control of it. They added dihedral, or upward sweep, to the wingtips, and came

up with a design that would fly. When it finally went to market in 1986, the "Wind Weapon" had merged the best aspects of hang gliding and wind surfing: it didn't go as fast as a conventional board, but it did allow a sailor to get airborne on some tiny waves.

Magruder's brother Jim joined the fledgling business, along with Rountree Rouse. Crowell dropped out and went back to hang gliding. Wind Weapons moved to Hood River, Oregon, in the Columbia River Gorge—home of 40-mph "nuclear winds" and a mecca for wind surfers—and waited for fame and fortune.

Meanwhile, wind surfing equipment had evolved, and back in Hawaii, the Maui Air Force had learned some incredible stunts. Flying off the top of a wave, they could loop forward and backward once, even twice, before alighting gracefully on the water. But sailsoaring, as the Magruders named their new sport, just never caught on. They sold less than 200 Wind Weapons and still have a warehouse full of aluminum tubing.

But they haven't given up. "Maybe five or 10 years from now the sport will develop like this," says Rouse, sitting on the shore of the Columbia watching hundreds of wind surfers skimming across the river. There is a lone Wind Weapon in the fray, sailed by Jim Magruder. He catches a little wave and rotates the sail that lifts him into the air, where he hangs for a few seconds before gently splashing down.

—Elaine de Man

Update

Sagdeev, Eisenhower Wed

Roald Sagdeev, the Soviet Union's engaging and outspoken space scientist, married Susan Eisenhower, granddaughter of the late president, in Moscow on February 9 ("The Space Statesman," October/November 1988). The couple met in 1987 at a conference on U.S.-Soviet relations. With five children from previous marriages between them, they plan to live in Washington, D.C., during the school year and spend summers in Moscow.



JAMES M. THRESHER/THE WASHINGTON POST

Soviet Space Accounts

For the first time, the Soviet Union has published its budget for space programs. Though the overall spending figure is known—6.9 billion rubles (\$4.14 billion) in 1989—no one can say what specific programs will be funded. A state plan is shifting manufacturing priorities in the space industry this year from space hardware to consumer goods.

According to Igor Belousov, the vice chairman of the USSR Council of Ministers and Chairman of the State Military Industrial Commission, the primary factory

for launch vehicles and spacecraft is now also expected to produce 718 types of processing equipment for the lighting, textile, clothing, and food industries. The facility, called the USSR Ministry of General Machine-Building, is only one of hundreds of organizations affected by the conversion.

Both military and civilian space enterprises have been cut to increase the manufacture of sports gear, tents, low-pressure tires, tableware, and medical instruments as well as the industrial equipment. But the military share of the space budget, 3.9 billion rubles, is more

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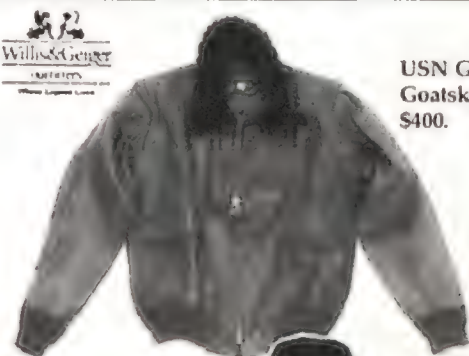
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than twice that of the civilian side, 1.7 billion rubles. A third category, Energia-Buran programs, is funded at 1.3 billion rubles.

Although the 1990 budget is expected to be 10 percent lower than 1989 spending, manned flights to the Mir space station will continue. This April Mir will get a new module with specialized furnaces for manufacturing pure crystals and solar panels that will produce eight kilowatts of electricity. Space program plans call for two other modules to be added to the station by 1992, but the conversion has delayed decisions on these and on the larger orbiter, the Mir-2, which was to have appeared in the late 1990s.

The Mir station itself is probably safe from budget cuts because its high costs are offset by international expeditions. A



British consortium is paying £18 million (\$30.8 million) to send a cosmonaut to Mir, and Japanese and Austrian cosmonauts will be paying guests as well. A U.S. firm, Payload Systems, has recently contracted to fly biological experiments aboard the space station.

—Mikhail Chernyshov
Novosti Press Agency

Shuttle Diplomacy

The East Coast air shuttle war has escalated beyond bagels and newspapers. Now Pan Am and Trump (*née* Eastern) are offering concierge and office services to court business executives, who constitute 80 percent of the Boston-New York-Washington passenger load.

Last June Pan Am introduced a "business center" for its frequent shuttlers. The Pan Am Business Club at La Guardia Airport's Marine Air Terminal has four fax machines, a personal computer, laser printer, conference rooms, overnight mail services, and a manager who will take dictation. Business centers have since opened at Washington and Boston.

Then, last October, Trump announced the inauguration of concierge services at all three airports, with a staff, according to an enthusiastic employee, that "will do anything legal to be nice."

"It's like a private club," says Trump concierge Susan Stizza from behind her polished walnut desk in the spacious and plushly carpeted lounge at La Guardia. "We give service par excellence." That service includes making reservations at hotels, restaurants, and health clubs; providing messenger and delivery services, faxing, and limousines on call; calling a passenger's home to deliver a message; and giving advice on how to kill a couple of hours in Washington, Boston, or New York—all at no charge to Trump frequent fliers. One passenger gave concierge Patty Murphy his credit card number and asked to have a birthday cake delivered to his girlfriend. Murphy couldn't find a bakery that

delivered, so she had it made at Donald Trump's Plaza Hotel and delivered by courier in a matter of hours.

Pan Am's Business Club at La Guardia is less glitzy. It looks like a working corner of the home office, but Pan Am will handle more than faxes and phone calls. An executive with a baby at home booked a Pan Am room and showed up with pumping equipment for nursing mothers. In the privacy of the conference room, she collected her baby's afternoon meal and had a courier deliver it for the nanny to serve.

Both airlines say their new services are well used, though neither has promoted them heavily. Harris K. Herman, chief operating officer for the Pan Am shuttle, says, "It's more than just a frill. It's important."

However, Herman thinks Trump's concierge system is superfluous. "I had trouble believing that business travelers don't usually have their trips all set up," he says. "There's just not a great demand among them for that. We don't see it here."

On one Friday morning at La Guardia last January, the pace seemed slow at both facilities. Perhaps some business travelers may be swayed by a bevy of fax machines or same-day birthday cake delivery, but right now most choose their shuttle by their watches: Trump on the hour, Pan Am on the half-hour.

—Peter Boody

Update

Trophy Winners

Two Daedalus pilots and high-altitude balloonist Per Linstrand are among the nine recipients of the 1986-1988 Harmon Trophy Certificates. Kanellos Kanellopoulos and Lois McCallin were cited for their flights in the human-powered Daedalus and its prototype ("How many light bulbs . . .," June/July 1988). Linstrand was awarded two certificates: one for his solo ascent to 64,997 feet ("Twelve Miles Over Laredo," December 1988/January 1989) and one for his transatlantic flight with Richard Branson. The two hot-air balloonists are planning a 100-hour trans-pacific flight in November, when the jet stream is at its strongest and its direction is most predictable.



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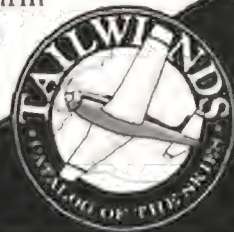
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Howard Hughes' Obsession

Pop quiz: Howard Hughes designed (a) the H-1 Racer, (b) the "Spruce Goose," (c) a bra for Jane Russell in *The Outlaw*, (d) all of the above. The answer, according to aviation and screen history, is (d). Which of these is his greatest legacy is, of course, a matter of opinion. But for many aviation enthusiasts the answer is the H-1 Racer—one of the most innovative airplanes of its era and also one of the most beautiful in the Museum. It is currently on exhibit in the Golden Age of Flight gallery.

Even before the H-1 Racer, Hughes pulled off an assortment of aeronautical exploits in Hollywood. His World War I epic *Hell's Angels* featured dogfights that were unmatched as aerial spectacles. It was while directing this movie that Hughes met a pilot-mechanic named Glenn Odekirk. Not satisfied with the airplanes he was flying, Hughes started talking with Odekirk about building his own, and the idea for the H-1 was born.

In a corner of a hangar at the Grand Central Airport in Glendale, Hughes, Odekirk, and a Lockheed engineer named Richard Palmer set out to build the world's fastest landplane. They chose a Pratt & Whitney Twin Wasp Junior radial engine to power the aircraft. Rated at 700 horsepower, it could be called on to deliver as much as 1,000.

But the real key to the H-1's speed was the airplane's streamlined fuselage with its highly polished aluminum finish. A close fitting bell-shaped engine cowl, wing fillets that gracefully faired the wing roots, and retractable landing gear figured prominently in drag reduction. Even the rivets, joints, and screws were flush with the aircraft's skin. So obsessed was Hughes with reducing drag that the hundreds of screws were adjusted so that their slots were aligned with the airflow.

Near Santa Ana, California, Hughes took off in pursuit of the record of 314 mph held by French pilot Raymond Delmotte. Flying a three-kilometer closed course, he attained a top speed of 352 mph, becoming at the age of 30 one of the youngest in a succession of speed kings to blaze across the skies between the world wars.

Unfortunately, the new record-setter forgot he had only a minimum of fuel to keep his weight down. When the engine quit, he landed wheels-up in a beet field.

Hughes next set his sights on the transcontinental record held by Roscoe Turner. He had the stubby 25-foot plywood wings, which were best for high speeds, removed from the H-1 Racer and new 32-foot wings installed. (These long wings are the ones now on exhibit.) At 2:14 a.m. on January 19, 1937, Hughes departed Burbank with 280 gallons of fuel; he flew over Newark Airport in New Jersey at 12:42 p.m. for an official coast-to-coast (2,490 miles) record of seven hours, 28 minutes, and 25 seconds.

A year later Hughes would set another world record when he flew around the world with a crew of four in a Lockheed Model 14 airliner. Hughes' talents as a pilot had earned him an invitation to the White House and a tickertape parade in New York

City. But the H-1 Racer, after only some 40 hours of flying time, was retired.

When it was donated to the Museum in 1975, the H-1 had spent three decades in a Hughes Aircraft hangar covered in sheets like a Halloween ghost. Originally Hughes had hoped to sell the H-1 as a fighter plane. But his idiosyncratic style, which had inspired the H-1, alienated the military brass. The airplane had a significant impact nonetheless, influencing the design of such World War II fighters as the F6F Hellcat and the P-47 Thunderbolt.

Hughes' early accomplishments would later be overshadowed by his eight-engine all-wood flying boat dubbed the Spruce Goose, as well as his reputed eccentricities. When he died in 1976, the rumors surrounding the reclusive multi-millionaire seemed at odds with the handsome playboy who four decades earlier had pursued Hollywood starlets and aviation records with equal aplomb.

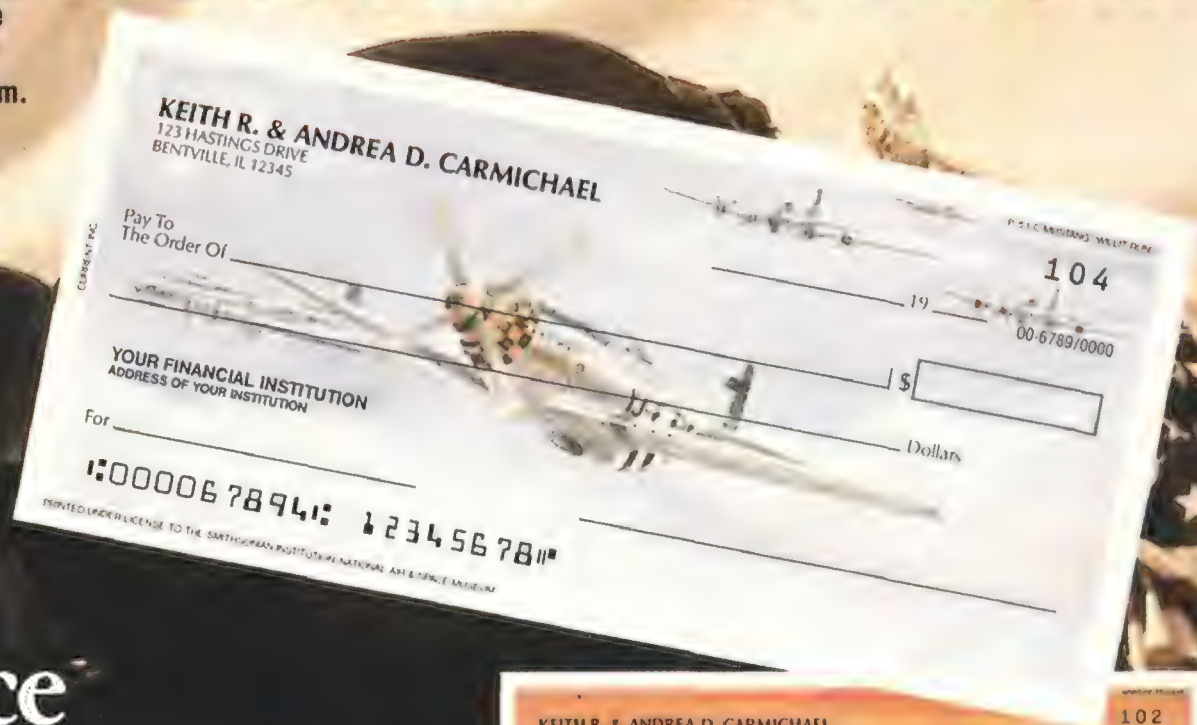
Thanks to his H-1 Racer, Howard Hughes became the fastest man alive in 1935.



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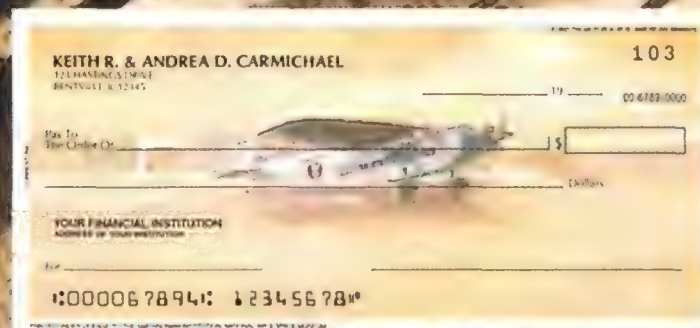
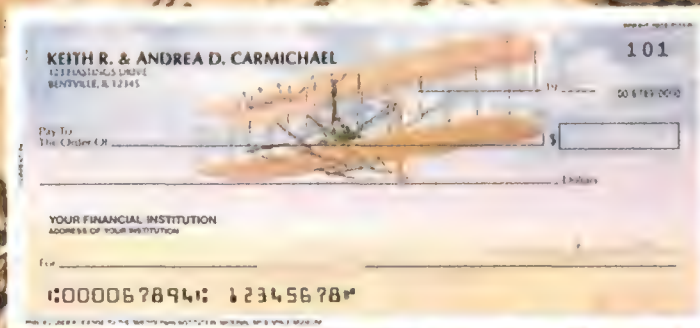
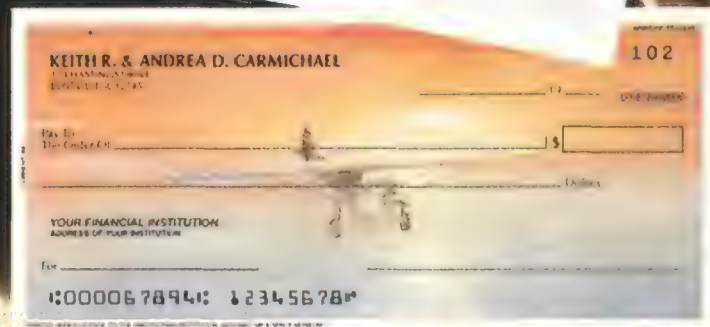
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Star-Hopping

"This is the price you pay for hauling an observatory around in the trunk of a compact car," says Geoff Chester as he wrestles his portable telescope out of its case. Except for a park ranger's flashlight, the glow of a cigarette, and a nine-day-old moon, it is dark—which is why some 50 people have gathered in a meadow far from the glare of the nation's capital for a peek at the Milky Way.

During the week, Chester produces slides and does other work for the Museum's planetarium. But on weekends he makes himself available to local park authorities at public stargazing programs. Between the momentum left over from Halley's Comet and plugs from local TV weathermen, Chester estimates that over 5,000 people have looked through his telescopes in the past several years. While he enjoys star-hopping with others around the universe, he admits to a hidden agenda—calling people's attention to light pollution, which leaves only the countryside dark enough to view the sky.

The stargazing kicks off with a Darth Vader imitation—Chester wields his flashlight like a light saber to point out various objects in the night sky to orient the crowd. First he points to three bright stars known as the summer triangle: Vega, Deneb, and Altair. He works his way around the heavens until he comes to Saturn, which is the first stop—900 million miles away—on the telescope tour.

Tonight it's hazy. Chester has brought along his 14-inch telescope for its light gathering ability. "It doesn't use lenses to form an image. It uses a big parabolic mirror," Chester explains, trying to make himself heard over the locusts and crickets. Basically it's the same type of telescope Isaac Newton invented 300 years ago—except Chester made this one at home with plywood, aluminum tubing, and a mirror. On an average night he can see details on the moon as small as one mile across.

When everyone has seen enough of Saturn, Chester aims for the Ring Nebula, a dwarf star with a ring of gas around it. It appears as a smudge of light—light that started its journey to us around the time of the Roman Empire. "And that's just a walk around the corner," Chester reminds everybody.

Now and then other amateur astronomers arrive with more telescopes. Lines form in the dark as folks wander across the meadow from telescope to telescope and wait their turn to view another part of the deep sky. It's not unusual for Chester to pull an all-nighter under the stars, but tonight he decides to

Artifacts



The Museum has hundreds of historical or technically significant air- and spacecraft in its collection; it also has Gilmore the Flying Lion. Now in storage at the Paul E. Garber Facility in Maryland, Gilmore flew over 30,000 miles as air racer Roscoe Turner's copilot for a publicity gimmick back in 1930. Turner even had a parachute made for the cub. Eventually Gilmore outgrew the cockpit, and when he died, the dashing pilot had him stuffed. "He's not one of the trophies," Turner would tell his visitors. "The trophies belong to him as much as they do to me."

pack it in around midnight. The diehards will stay for another couple of hours waiting for Jupiter, the Pleiades, and the Orion Nebula to appear.

The following Monday finds Chester back in his office, still starry-eyed and a little bleary-eyed as well. "There's something wonderful," he says, "about staying up, getting tired, kind of fumbling around at three o'clock in the morning when there are shooting stars whizzing overhead . . ."

—David Savold

Museum Calendar

Except where noted, no tickets or reservations are required. Call Smithsonian Information at (202) 357-2700 for details.

New Exhibit "Modern Carrier Aviation: Seapower in a Changing World." Highlights major technological innovations. Opens April 27 in the Sea-Air Operations gallery.

Open House "Wings and Things," open house at the National Air and Space Museum's Paul E. Garber Preservation, Restoration and Storage Facility, Suitland, Maryland. April 28 and 29, 10 a.m.–3 p.m.

April 3 Stealth Bomber Lecture: "From Flying Wing to B-2." E.T. Wooldridge, NASM, and Irving Waaland, member of the

original design team. Langley Theater, 8 p.m.

April 5 General Electric Aviation Lecture: "Aviation in Antarctica." Richard W. Manning, teacher, lecturer, writer. Langley Theater, 7:30 p.m.

April 7 Monthly Sky Lecture: "Comet Austin." Dan Costanzo, amateur astronomer. Einstein Planetarium, 9:30 a.m.

April 11 Exploring Space Lecture: "The Great Attractor." Alan Dressler, Carnegie Institution. Einstein Planetarium, 7:30 p.m.

May 3 Legacy of Strategic Bombing Lecture: "Dresden: The View from the Ground." Kurt Vonnegut, novelist. Langley Theater, 8 p.m.

May 9 Exploring Space Lecture: "Millisecond Pulsar Searches." Ramesh Narayan, University of Arizona, Tucson. Einstein Planetarium, 7:30 p.m.

May 11 Igor Sikorsky Symposium: To be announced. Aviation historians trace the aviation pioneer's work. Langley Theater, 9 a.m.

May 17 General Electric Aviation Lecture: To be announced. Najeed Halaby, former Federal Aviation Administration administrator. Langley Theater, 8 p.m.

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Freefall

Imagine you are under water, free to flip forward and back and twist without falling. Now imagine that you don't have to come up for air or wear cumbersome breathing equipment. Then imagine the same thing without the water to slow you down, and you get the idea. You are not in water after all, but the open cabin of a NASA KC-135, a modified Air Force refueling tanker that flies parabolic arcs to introduce people to weightlessness.

You float, enjoying total freedom of movement. No longer confined to two dimensions, you find the ceiling as good a place to loiter as the walls or the floor. "Up" becomes meaningless. A good game is to turn upside down, touch your feet to the ceiling, and mentally invert the airplane so that everyone else seems to be upside down. Astronauts sometimes experience the same illusion during spaceflight. When a clear path exists, the more practiced fliers can gently push off a wall and coast the length of the fuselage. You can toss items to one another with the slightest nudge, and you have to concentrate to avoid pushing with your legs to hold yourself up. After a week, all this becomes fun, but I can tell you from experience that it doesn't start out that way.

On the day of my first flight, the aircraft was filled with several teams of scientists—including some future space shuttle crew members—and their equipment. The Air Force had schooled me on the symptoms of hypoxia and how to use oxygen equipment. The preflight briefing aboard the airplane covered more safety pointers: Be careful not to touch the photo lights in the walls that come on during the 25-second weightless period; they're hot. There's a signal that warns of lost cabin pressure, and even an alarm that tells you the airplane is going to hit the ground. And we were told just enough about how to use a parachute to make me feel dangerous. Finally, we were advised that if we didn't know what we were doing, we shouldn't fool around. If you're up near the ceiling and you fall to the floor, you could hurt someone.

And then there's motion sickness.

About half of all first-time fliers get sick,

and any shyness about it was quickly dispelled as the little white plastic bags were handed out. Most of us had heard of this airplane's reputation, and because I work in a university laboratory where my colleagues devise clever ways to induce motion sickness, I had more than a passing awareness of the phenomenon. There was some solace in knowing that everyone on board had something to do during the flight, so nobody had time to watch me. It is even something of a badge of honor to suffer motion sickness but still hang in there and do the job—and come back for more the next day. If you don't use your bag in time, it's your responsibility to clean up afterwards, so we all trudged to our seats with the bags stuck in our breast pockets

Astronauts Anna Fisher and Frederick Hauck go parabolic with a NASA physician as observer.



like cheap artificial flowers.

We took off from Ellington Air Force Base at the Johnson Space Center near Houston, Texas, and after reaching cruising altitude headed out over the Gulf of Mexico. The airplane would fly a series of 20 parabolic arcs between 24,000 and 35,000 feet. The test director signaled us to get ready. I was half hoping an equipment problem would arise and send us home early, but everyone began unbuckling their

seat belts and moving into position to go to work.

Our experiment would test how vision and gravity sensors interact in the brain to help establish a sense of orientation. During the weightless period, the experimental subject peers into a large dome that rotates around his line of sight, inducing an intense sensation of spinning head over heels. This experiment will eventually fly on the shuttle, but we were testing procedures and allowing the future astronauts to experience the sensation before trying it in orbit. We powered up the system and took our places. I knelt in front of a computer terminal, my legs under a cargo strap so I wouldn't float away.

Things started to get heavy as the airplane began a pull-up that created a force of about twice that of gravity. If I didn't move around a lot it wasn't too uncomfortable, but as we entered the first parabola, strange things began to happen. Never having experienced anything like it, my brain got a bit confused. My first sensation on entering weightlessness was that both my computer and I had tilted forward so that I was looking down at the display screen from above. I immediately tensed up until my knuckles turned white from gripping the handles on the equipment rack.

Fortunately my colleague, a veteran, stood close by during my first few parabolas. "Relax. Relax. Don't fight it. Let it happen," he advised. But I couldn't help thinking that if I held on tighter I could stop the uneasy feeling that my insides were trying to escape through my throat.

The crew takes a break after 20 parabolas, then does 20 more. I got sick before we reached the halfway point in the first set, and although the break brought relief, it ended too quickly. I dreaded the next cycle and counted each parabola to the end. It's total misery to know that the next weightless phase is coming and that you're not going to like it, but there's nothing you can do and nowhere to go. The cabin got smaller and smaller. I kept my head plastered to the computer screen—when you play with gravity, moving your head



NASA's Boeing KC-135 streams fuel as it enters the up side of a parabola.

only aggravates motion sickness. I knew other people were having fun; I could hear them. I started calculating whether we had enough people to handle all the tasks if I didn't fly tomorrow.

That flight lasted two hours. Between the motion sickness medication (it was of little value), the anxiety, and the work, I was drained. But it felt good to get off the airplane and back on firm ground. I began to feel better, almost as if I'd become an accomplished veteran after only one flight.

Maybe I *would* try it again.

The next day was better; I didn't get sick until the end, although I kept very still throughout the flight. The day after that was better still. By the end of the week I was turning upside down and spinning around—all I could do within the limits of my headset cord. And I was lucky; I had another whole week of flights coming up during which I would be well adapted. Zero-G flying had become fun.

I still can't describe the actual sensation

of weightlessness, though. The more accurate term for what I experienced is "freefall," yet I never felt as if I were falling because the airplane and everything in it fell together. It's similar to the stomach-in-the-throat feeling you get on a roller coaster, but it's drawn out over 20 seconds and not as violent. Unless I could see the clouds through a window, I had no sense of the airplane pitching from 45 degrees upward to 45 degrees downward.

The 2-G pullout is a different matter. It's not uncomfortable, although you quickly learn that head movements during this phase are much more nauseating than those attempted during the zero-G phase. If you tilt your head down a bit, the gravity sensors in your inner ear indicate that you've tilted twice as far as you really have, and they signal the eyes to move accordingly to counteract the head motion and maintain stable vision. Because the signal is too strong, the eyes move too much, and it seems like the floor of the aircraft rushes up to meet you and bounces into place. Things get heavy too, but not unbearably so. It's more comfortable to kneel or lie down during this part, but if you're standing and bend your knees you come down to the floor in a hurry.

At the end of the flight you have a wonderful sense of accomplishment. You're bubbling over with the urge to tell someone about the experience. But everyone on the plane has gone through it already, some of them hundreds of times, so you may simply exchange knowing glances with another rookie, or sneak a look at the faces of first-timers and remember how awful that first flight was.

My second week of flights went by quickly. I strode out to the airplane each morning and listened to the preflight briefings for the newcomers while I went about my business, now nonchalant about the day's coming adventure. After two weeks I had accumulated over an hour and a half of weightless time, and I was hooked. Now I'm trying to rearrange the rest of my research career so I can get more time on that airplane.

—Mark Shelhamer



B

ill Rice, the bug, the plow, and the Lands' End Interlochen Knit Shirt

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Bill Rice, ready to meet the President
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A shirt good enough to meet the President.

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"I wear them everywhere I go. Working out here on the ranch, and going into town too."

Bill says it's the comfort of the shirt that's got him sold. Along with the way it looks. (He owns six of the shirts he's pictured in here!)

"If I was going to meet the President," says Bill with a twinkle in his blue eyes, "I'd wear this shirt."

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There wasn't much moving on that shimmering hot summer day not long ago, on a West Texas ranch. Just a skittish lizard, here and there.

And a tractor, plowing the fields, driven by a man named Bill Rice.

Now, summertime and bugs seem to go together like bacon and eggs. So it wasn't surprising that pretty soon, a bug crawled down into the Lands' End Interlochen Knit Shirt that Bill happened to be wearing that day.

(While we have gotten pretty well acquainted with Bill Rice, we can't tell you anything about this bug, whether it was a brave bug or an ornery bug, a wise old bug or a foolish young bug. It disappeared without giving any interviews.)

Anyway, we'll let Bill tell you what happened at this point, in his own words.

"There wasn't room for me and the bug, so I yanked the shirt off and just hung it on the back of my tractor.

"Well, to make a long story short, the shirt fell down and I accidentally plowed it under. After I plowed it back up and threw it in the washing machine, it was still as good as new. Now that's a well-made shirt."

Never Say Fly

December may seem a long time ago to you, but to some of us the month remains evergreen. It is the season when we members of the Man Will Never Fly Memorial Society meet in strenuous opposition to the arcane rituals of those lesser folk who mark "the first flight." For it was on a December day in 1903 that the brothers Wright perpetrated the world's greatest hoax. And every December the MWNFMS reminds right-thinking citizens that two Wrights made a wrong. As a new member, I take this stuff seriously.

I got hooked during a visit to Kitty Hawk, North Carolina, to meet Ed North, one of the MWNFMS founders. He is a grizzled, cordial, hospitable heretic who once flouted regional loyalties by pasting a question mark after the phrase "First In Flight" on his license plate.

Ironically, in the late 1940s North was one of the Coast Guard's flying doctors, making housecalls in the roadless Outer Banks by helicopter. Later, he retired to the dunes and found only one drawback.

"I got tired of watching folks fly in every December 17, soberly pay homage at the Wright Memorial, and then fly off again. They never had any *fun*." Also, he adds, there were never enough people in the Outer Banks in December to have a party. In 1958, North and Jack Aulis, a Raleigh newsman and author, established their society of non-believers. "We mulled it over in a bar one afternoon," says North. "You might say our society was inspired by martinis."

I gleaned that the first group met at one of the hotels around Nags Head the following December 16, the day before the Wrights' anniversary. Happy hour ran 18 hours, 35 minutes, briefly interrupted by dinner. That schedule has since become an honored tradition, but the sites change regularly, since few hotel managers want to go through this twice.

North and Aulis say membership boomed, first through word of mouth, then because the media caught on. "I don't know how many members we have now," says North, "because I haven't checked over all the plane crashes in 1989. But we've

printed 5,000 cards."

The Man Will Never Fly Memorial Society (its auxiliary is called Nor Woman, Neither) includes VIPs like Senator John Glenn and other disciples of the great truth that airplane flight is a massive hallucination. Astronaut Mary Cleave was inducted into the society's Anti-Aviation Hall of Infamy after working on a toilet for the space shuttle. When it failed to operate, North gleefully telegraphed her, "Man Will Never Fly—Nor Flush."

The annual meeting begins with awards, like the one given to Chuck Yeager in 1963 "for being clumsy enough to break the sound barrier." Then members discuss pet projects, such as recycling aircraft into beer cans, maintenance of the society's Invisible Museum for UFOs, and organizing a tour of all the sites where man claimed to have first flown, starting at Kitty Hawk with continuing service to Connecticut, Texas, New Zealand, Paris, "and somewhere in Russia," says North.

Eventually dinner arrives, usually something like Grounded Beef with Crashed Potatoes. Then North introduces the guest speaker. In 1988 it was Apollo 11 astronaut Michael Collins, who is also a former director of the National Air and Space Museum. He announced that the moon landing had been filmed on a Carolina sand dune, that the landing module was a '54 Ford pickup, and that astronauts tend to be "like the Platte River in summer: three inches deep and a mile wide at the mouth." He also credited the audience with being "beachcombers, misfits, drunks—the flotsam and jetsam of society. My kind of people."

Each meeting has as its theme a means of transportation that keeps you firmly on the ground, or under it: last year it was the subway. The bus and the pogo stick have



MARK AVINO/NASM

been similarly honored.

I received my membership certificate after voicing an oath that I "will never fly, or, given no choice, will never fly sober," along with a white scarf bearing the motto "Birds Fly—Men Drink." I also learned the chorus of the MWNFMS song:

*Oh, fill up your glasses
And let's have a round
For Wilbur and Orville,
Those men of renown
Who taught us to fly
Without leaving the ground,
And that's what we're doing tonight.*

Blinded by further revelations imparted on the drive back to the Norfolk terminal, I breasted the bar before boarding a bus home. It was like any other bus ride except for the staging—the "wings" and the cloud backdrop being rolled past the windows. No wonder the ticket cost so much.

—Edwards Park



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THE FLYING CROWBAR

Those who came of age during the era of Three Mile Island and Chernobyl are probably too young to remember the happy days when “our friend the atom” promised electricity too cheap to meter and cars that would run forever without a fill-up. With atom-powered subs like the *Nautilus* cruising under the polar icecap in the mid-1950s, could anyone doubt that atom-powered rocketships, airplanes, and even automobiles would be far behind?

A funny thing happened to that dream on its way to reality: Americans discovered radiation. Project Orion, a futuristic atom bomb-powered rocketship, was grounded in 1963 when the Nuclear Test Ban Treaty forbade atomic explosions in outer space (see “A Spaceship Named Orion,” October/November 1988). A nuclear-powered bomber never got off the runway after the Air Force started advertising for pilots past child-rearing age. Later, Congress learned that if such a bomber crashed, the site would become “uninhabitable.” *Uninhabitable?*

Less than a decade after the debut of the Eisenhower administration’s pro-nuclear power “Atoms for Peace” campaign, nuclear energy no longer meant cheap power and strawberries the size of footballs but man-eating ants and Godzilla.

Fatefully, Sputnik was launched when the dream of the omnipotent atom was still very much alive. Realizing that the Soviets were ahead in missiles, Americans became concerned that they might be ahead in anti-missile missiles as well. To counter that threat, Pentagon planners decided they needed an unmanned atomic bomber or a nuclear-powered cruise mis-

Once it switched from booster rockets to nuclear power, Pluto would have been a danger to friend and foe alike.







The 25 miles of oil well casing needed to store air for ramjet simulations dominated Pluto's test site at Jackass Flats.

sile able to fly below enemy defenses.

What they came up with was SLAM, for Supersonic Low-Altitude Missile. SLAM was to use a revolutionary new type of propulsion: nuclear ramjet power. The project to build the weapon's nuclear reactor was given the code name "Pluto," which also came to refer to the weapon itself.

Pluto's namesake was Roman mythology's ruler of the underworld—seemingly an apt inspiration for a locomotive-size missile that would travel at near-treetop level at three times the speed of sound, tossing out hydrogen bombs as it roared overhead. Pluto's designers calculated that its shock wave alone might kill people on the ground. Then there was the problem of fallout. In addition to gamma and neutron radiation from the unshielded reactor, Pluto's nuclear ramjet would spew fission fragments out in its exhaust as it flew by. (One enterprising weaponeer had a plan to turn an obvious peacetime liability into a wartime asset: he suggested flying the radioactive rocket back and forth over the Soviet Union after it had dropped its bombs.)

Like Hula Hoops and Slinkies, Pluto is now an anachronism, an all-but-forgotten remnant of an earlier—but not necessarily more innocent—era. At the time, however, deadly as it would have been, Pluto had the almost irresistible appeal of any

radically new technological innovation. Like the H-bombs it would carry, Pluto was "technically sweet" to many of the scientists and engineers who worked on it.

On January 1, 1957, the U.S. Air Force and the Atomic Energy Commission picked the Lawrence Livermore National Laboratory, located just over the hills from Berkeley, California, as Pluto's home. Since Congress had recently given a joint project to build an atom-powered rocket to Livermore's arch rival, the Los Alamos National Laboratory in New Mexico, the assignment came as welcome news.

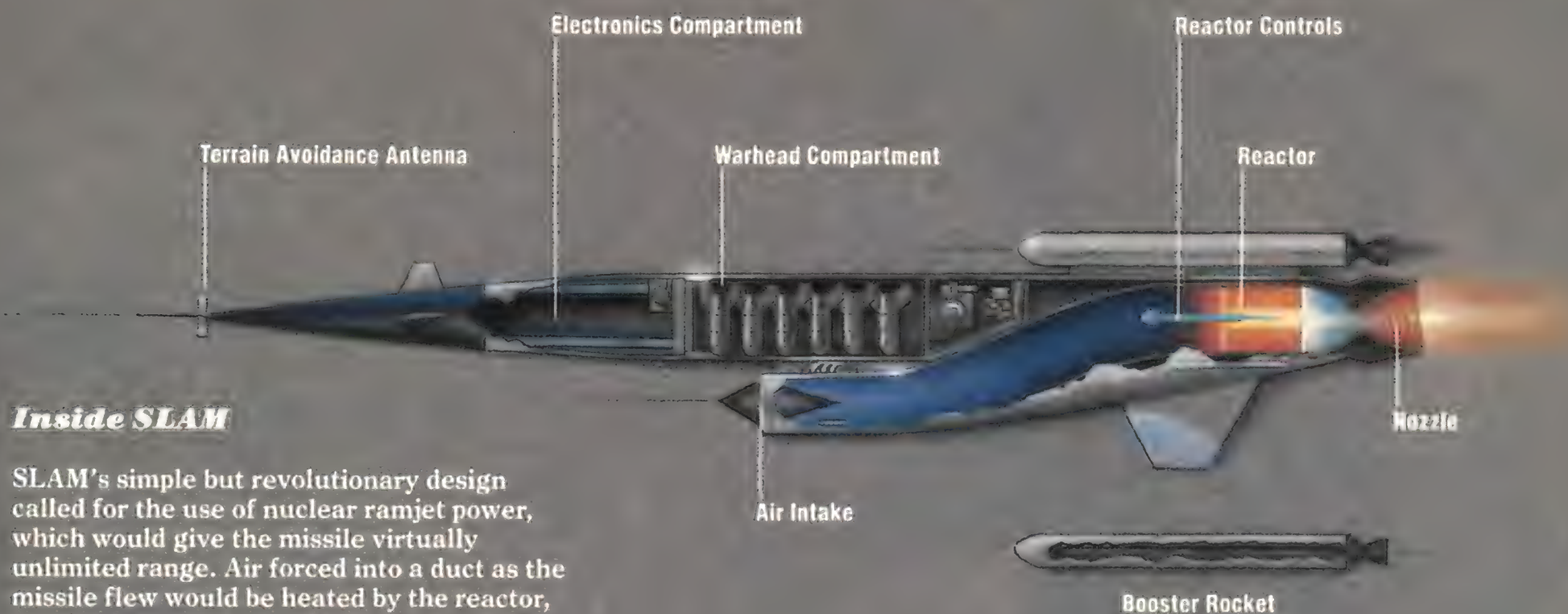
Still, Pluto was not a make-work project or a welfare program for Livermore's highly skilled physicists and engineers. The design and construction of a nuclear ramjet posed a daunting array of technological challenges.

The idea behind any ramjet is relatively simple: air is drawn in at the front of the vehicle under ram pressure, heated to make it expand, and then exhausted out the back, providing thrust. But the notion of using a nuclear reactor to heat the air was something fundamentally new. Unlike commercial reactors, which are surrounded by hundreds of tons of concrete, Pluto's reactor had to be small and compact enough to fly, but durable enough to survive the several-thousand-mile trip to targets in the Soviet Union.

The success of Project Pluto depended upon a whole series of technological advances in metallurgy and materials science. Pneumatic motors necessary to control the reactor in flight had to operate while red-hot and in the presence of intense radioactivity. The need to maintain supersonic speed at low altitude and in all kinds of weather meant that Pluto's reactor had to survive conditions that would melt or disintegrate the metals used in most jet and rocket engines. Engineers calculated that the aerodynamic pressures upon the missile might be five times those the hypersonic X-15 had to endure. Pluto was "pretty close to the limits in all respects," says Ethan Platt, an engineer who worked on the project. "We were tickling the dragon's tail all the way," says Blake Myers, head of Livermore's propulsion engineering division.



Mounted on a railroad car, Tory-IIIC is readied for its highly successful May 1964 test.



Inside SLAM

SLAM's simple but revolutionary design called for the use of nuclear ramjet power, which would give the missile virtually unlimited range. Air forced into a duct as the missile flew would be heated by the reactor, causing it to expand, and exhaust out the back, providing thrust.



The centerpiece of the Pluto effort, the Tory reactor was designed to be durable but compact enough to fly.

In the movie *Dr. Strangelove*, the pilot of a low-flying B-52 assures his crew that "they might harpoon us, but they dang sure ain't going to spot us on no radar screen." Pluto would operate on the same strategic principle. In order to reach ramjet speed, it would be launched from the ground by a cluster of conventional rocket boosters. Not until it was at cruising altitude and far away from populated areas would the nuclear reactor be turned on. Since nuclear power gave it almost unlimited range, the missile could cruise in circles over the ocean until ordered "down to the deck" for its supersonic dash to targets in the Soviet Union. Relying upon the same terrain comparison guidance system (TERCOM) used by modern cruise missiles, Pluto would come in below enemy defenses to hit its targets with pinpoint accuracy. Unlike modern cruise missiles, however, one SLAM would be able to strike up to a dozen widely separated targets.

Because of its combination of high speed and low altitude, Pluto promised to get through to targets that manned bombers and even ballistic missiles might not be able to reach. What weaponeers call "robustness" was another important advantage. "Pluto was about as durable as a bucket of rocks," says one who worked on the project. It was because of the missile's low complexity and high durability that physicist Ted Merkle, the project's director, called it "the flying crowbar."

Merkle, a fittingly unorthodox figure at Livermore (see "Cutting the Gordian Knot," p.33), was given responsibility for the design of the 500-megawatt reactor that would be Pluto's heart. The Air Force had already given Chance-Vought the contract for the airframe and Marquardt Aircraft the job of building the rest of the ramjet engine.

Because the efficiency of a nuclear ramjet increases with temperature, "the hotter, the better" became Merkle's motto for the reactor, code-named "Tory." But at Tory's operating temperature of 2,500 degrees Fahrenheit, even high-temperature alloys would become white-hot and lose structural strength. So Merkle asked a Colorado-based porcelain company named Coors to manufacture ceramic fuel elements that could stand the heat and provide even temperature distribution in the reactor.

The company is well known today for a much different product: while making ceramic-lined vats for breweries around the country, Adolph Coors realized that he might be in the wrong business. Although the Coors Porcelain Company continued to make porcelain—including all of the nearly 500,000 pencil-shaped fuel elements used in the Tory reactor—the brewery Adolph Coors opened near his ceramics factory soon became the tail that wagged the dog.

But Tory's extreme operating temperature was just the beginning of problems to be overcome. Flying a reactor at Mach 3 through rain, snow, and salt air posed another set of difficulties. Merkle's engineers experimented with a variety of heat- and corrosion-resistant materials for the critical base plates at the aft end of the reactor, where the temperatures would be highest. Just measuring the temperature of the base plates presented a challenge, since heat-sensitive probes



Cutting the Gordian Knot

As the technical director of Project Pluto at the Livermore lab, Ted Merkle was "a strong wind blowing through the place," says colleague Jim Hadley. To Richard Werner, in charge of developing the base plates for the Tory reactor, Merkle was "a perfect combination of physicist and pitchman—always running around and shaking things up."

Not all remembrances of him are so kind. One associate calls Merkle "a bull in a china shop." Concedes Hadley, "He wasn't interested in untying the Gordian knot. He cut it."

In fact, Merkle's impatience was legendary. Testifying before Congress on spaceships of the future, Merkle dubbed a nuclear rocket then under development at the rival Los Alamos lab "Old Pokey." He said he wanted to explore the cosmos in a near-light-speed, ion-propelled rocket.

The Pluto project helped steer Merkle's dream of the stars back down to Earth.



LAWRENCE LIVERMORE NATIONAL LABORATORY

Still, he remained impatient. Engineer Blake Myers vividly recalls Merkle driving his old and "totally ripped" Packard convertible at high speed through the lab's parking lot.

Some colleagues attributed Merkle's hard-driving personality to the strain of trying to raise three kids on a teaching assistant's salary. Merkle himself boasted that, while a graduate student at Berkeley

in the early 1950s, he was often reduced to feeding his family horsemeat.

While director of Pluto, Merkle forbade "canned briefings" of the military or Congress. "You use chalk and you talk off the top of your head because you know it," he instructed co-workers. "He had no patience whatsoever with people who didn't know how to do things," Werner recalls.

That included his doctors. Merkle, diagnosed as having liver cancer about the time Project Pluto was cancelled, became frustrated with what he felt was the glacial pace of medical technology. Together with Werner—the engineer who devised an ingenious way of taking Tory's temperature—he invented an early version of the CAT scan using the lab's computers. "We made a topographical map of Merkle's liver," Werner says.

The patient himself watched the inexorable course of his disease with equanimity. "He knew there was no cure," Werner recalls. "His interest was scientific."

would be burned and blasted by Tory's searing heat and radiation. So close were the tolerances that Tory's base plates had an auto-ignition point only 150 degrees above the reactor's peak operating temperature.

In fact, so many unknowns surrounded Pluto that Merkle decided that it would take a static test of the full-scale ramjet reactor to resolve them all. To carry out the tests, Livermore built a special facility in a desolate stretch of Nevada desert close to where the lab had exploded many of its nuclear weapons. Designated Site 401, the facility—built on eight square miles of Jackass Flats—rivalled Project Pluto itself in ambition and cost.

Since Pluto's reactor would become intensely radioactive when run, a fully automated railroad had to be constructed to move the reactor the nearly two miles that separated the static test stand from the massive disassembly building, where the "hot" reactor would be taken apart and examined by remote control. Scientists from Livermore would watch the reactor tests on television in a tin shed located far away from the test stand and equipped—just in case—with a fallout shelter containing a two-week supply of food and water.

Just to supply the concrete for the six- to eight-foot-thick walls of the disassembly building, the U.S. government had to buy an aggregate mine. It took 25 miles of oil well casing to store the million pounds of pressurized air used to simulate ramjet flight conditions for Pluto. To supply the high-pressure air, the lab borrowed giant compressors from the Navy's submarine base in Groton, Connecticut. For a five-minute, full-

power test, as much as a ton of air a second had to be forced over 14 million one-inch steel balls in four huge steel tanks raised to 1,350 degrees Fahrenheit by oil-burning heaters. (Not all dimensions at Site 401 were enormous. When the lab's technicians proved too big to work in Tory's tight confines, a petite secretary from Blake Myers' staff inserted the final set of diagnostic instruments.)

Gradually but relentlessly over the project's first four years, Merkle and his team overcame the obstacles in Pluto's way. After a number of exotic materials had been tried and found wanting as a coating for electric motor armatures, engineers found that exhaust manifold paint—obtained through an ad in *Hot Rod* magazine—worked perfectly. When assembling the reactor, the lab's wizards cleverly held support springs in place with mothball spacers, which evaporated after serving their purpose. Another enterprising engineer on Merkle's staff, Richard Werner, invented a way of measuring the heat of the base plates by comparing movie film of the operating reactor to a temperature-calibrated color scale.

On the afternoon of May 14, 1961, as scientists and engineers in the control shed collectively held their breath, the world's first nuclear ramjet, mounted on a flatbed rail car and painted fire engine red, roared to life. Tory-IIA ran for only a few seconds, and at merely a fraction of its rated power. But the test was deemed a complete success. Most importantly, the reactor did not catch fire, as some nervous Atomic Energy Commission officials had worried it would. Almost immediately, Merkle began work on a second Tory—lighter in weight but even more powerful.

Tory-IIB never got beyond the drawing board, but three years almost to the day after the test of the first reactor, Tory-

How can you test-fly a highly radioactive missile? One proposal favored flying it over—and into—the Pacific.

Following Pluto's cancellation, technical director Ted Merkle awarded SLAM tie tacks and appropriately sinister-looking bottles of mineral water to project members.



LAWRENCE LIVERMORE NATIONAL LABORATORY (2)

IIC shattered the desert calm. Tory-IIC was run again the following week for five minutes at full power, producing 513 megawatts and the equivalent of over 35,000 pounds of thrust; less radiation escaped in the reactor stream than had been expected. The test was witnessed—at a safe distance—by dozens of admiring AEC officials and Air Force generals.

To celebrate their success, Merkle and his co-workers loaded a piano “borrowed” from the nearby women’s dorm onto a flatbed truck. With Merkle at the keyboard the group careened into the town of Mercury, site of the nearest bar, singing bawdy songs. The following morning, subdued but still happy, the celebrants lined up at the lab’s medical tent for the vitamin B-12 shots that in those days were thought to cure hangovers.

Returning to the lab, Merkle concentrated on making the reactor lighter, more powerful, and compact enough to be test-flown. There was even excited talk of a Tory-III, capable of propelling the missile to Mach 4.

Meanwhile, at the Pentagon, Pluto’s sponsors were having second thoughts about the project. Since the missile would be launched from U.S. territory and had to fly low over America’s allies in order to avoid detection on its way to the Soviet Union, some military planners began to wonder if it might not be almost as much a threat to the allies. Even before it began dropping bombs on our enemies Pluto would have deafened, flattened, and irradiated our friends. (The noise level on the ground as Pluto went by overhead was expected to be about 150 decibels; by comparison, the Saturn V rocket, which sent astronauts to the moon, produced 200 decibels at full thrust.) Ruptured eardrums, of course, would have been the least of your problems if you were unlucky enough to be underneath the unshielded reactor when it went by, literally roasting chickens in the barnyard. Pluto had begun to look like something only Goofy could love.

Outside the lab, questions were also being raised as to whether Pluto could do the job it was designed to do—and indeed, whether that job was still necessary. Although Livermore boasted that Pluto was “destined to be as evasive” as the planet with the same name, military analysts had begun to wonder if anything so big, hot, noisy, and radioactive could go undetected for long. Moreover, since the Air Force had already begun deploying ballistic missiles like Atlas and Titan

that would reach their targets hours before the flying reactor, critics charged that SLAM really stood for “slow, low, and messy.” The Navy, which had originally expressed an interest in firing the missile from ships or submarines, also began to back away from the project after successful tests of its Polaris missile. Finally, at \$50 million apiece, there were doubts that SLAM was worth the price. Pluto was suddenly a technology without an application, a weapon without a mission.

But what drove the last nail into Pluto’s coffin was a question so deceptively simple that the wizards at the lab might be excused for deliberately overlooking it: Where do you flight-test a nuclear reactor? “How are you going to convince people that it is not going to get away and run at low level through Las Vegas—or even Los Angeles?” asks Jim Hadley, a Livermore physicist and Pluto alumnus who now works on detecting foreign nuclear tests for the lab’s hush-hush Z Division. There was, admits Hadley, no way of guaranteeing that Pluto would not become a nuclear-powered juggernaut beyond its inventors’ control—a kind of airborne Frankenstein, a flying Chernobyl.

One proposed solution was to tie Pluto to a long tether in Nevada. (“That would have been some tether,” Hadley observes dryly.) A more realistic alternative was to fly Pluto in figure eights near Wake Island, a U.S. territory in the Pacific, then bury the “hot” missile in 20,000 feet of ocean. Even at a time when the AEC was trying to get the public to think of radiation in terms of “sunshine units,” the proposed dumping of scores of contaminated missiles in the Pacific was enough to give people pause.

On July 1, 1964, seven years and six months after it was born, Project Pluto was cancelled by the AEC and Air Force. At a country club near Livermore, Merkle hosted a “last supper” for those who had worked on the project, where SLAM tie tacks and bottles of “Pluto” mineral water were handed out as souvenirs. The total cost of the project had been \$260 million, in the pre-inflationary dollar of the day. At its peak Pluto had employed some 350 people at the lab and an additional 100 at Nevada’s Site 401.

Although Pluto never flew, the exotic materials developed for the nuclear ramjet find application today in ceramic turbines and space-based power reactors. Harry Reynolds, the project physicist for Tory-IIC, now works for Rockwell on the Strategic Defense Initiative.

For some at Livermore, a lingering nostalgia about Pluto remains. “It was the best six years of my life,” says William Moran, who oversaw the production of the Tory fuel elements. Chuck Barnett, who directed the Tory tests, succinctly sums up the gung-ho spirit at the lab: “I was young. We had lots of money. It was very exciting.”

Every few years, according to Hadley, some fledgling lieutenant colonel in the Air Force discovers Pluto and calls the lab to ask what happened to the nuclear ramjet. Enthusiasm quickly fades, Hadley says, when the questioner hears about the problems with flight-testing and radiation. Hadley has yet to receive a call back.

If someone were indeed serious about wanting to revive Pluto, he would probably find some ready recruits at Livermore. But not many. What was once the weapon from hell now seems an idea best left dead and buried. —



“We use one of the largest vacuum chambers in the world to test our nose cones. The testing lets us see exactly what will happen when the cone is explosively separated to release a satellite into orbit.

But we needed a better way to control the nose cone during separation, to keep the cone from getting damaged or from causing any damage to the walls of the chamber.

Well, I climb mountains in my spare time. Crazy as it may seem, that’s how I got the answer to our problem. I figured we could get the control by hooking up the kind of rip-stitch shock absorbers that climbers use to stop their falls.

The whole team pitched in and made the idea work. We count on each other. And that can be as exciting as mountain climbing.”

— Chris Fuld, Space Systems Development, Manager Test Engineer
(2nd from left) with Fred Eckhardt, Senior Engineer-Scientist (left),
Dick Durant, Senior Engineer-Scientist (right),
Bob Frenchick, Senior Engineer-Scientist (3rd from left)

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A night sky with two bright meteor streaks and a city skyline at the bottom. The sky is dark blue with numerous small, bright stars. Two bright, white meteor streaks are visible, one longer and one shorter, both angled diagonally across the frame. The bottom of the image shows a city skyline at night, with lights from buildings and streets visible.

Meteorites by Mail

**There's money to be made in meteorites—but
first you have to get your hands on them.**



by Dennis Stacy

It came crashing out of a clear blue sky shortly after noon on August 2, 1946, accompanied by a sonic boom heard 65 miles away. Horses grazing on the huge Gage Ranch in far west Texas stampeded for cover. Inside the two main houses, the Roxana Catto and Donald E. Forker families were eating lunch when the boom rattled windows and crockery. The Cattos' cook, a survivor of the Spanish Civil War, dove for cover under the dinner table. Mrs. Catto, my wife's grandmother, thought a sudden thunderstorm had blown in, until she noticed that the sun was still shining. Daughter Joan, then 13, shared the cook's fears. "The war was just over," she remembers, "and everyone was still a little jittery. I couldn't imag-

ine what else it could be."

Nearby, two cowboys were driving past the shallow, dammed-up Peña Blanca Springs when a fountain of foam suddenly erupted from the water and doused their pickup. After a cosmic journey that had begun well over a billion years earlier and traversed countless miles of cold, empty space, the chunk of rock later named the Peña Blanca Springs meteorite had arrived on Earth.

Thanks to its well-witnessed daylight splashdown, the meteorite was relatively easy to recover. Within a week, Oscar Monnig, an amateur meteoriticist from Fort Worth, was on the scene to supervise the draining of the springs. He retrieved almost 300 pounds of meteoritic material from the

muddy pond. Monnig was allowed to keep a small amount for analysis; the greater portion was divided between the Catto and Forker families. Now, more than 40 years after its fateful fall, the Forker half of the Peña Blanca is on sale to the public.

Purchasing a personal chunk of outer space can be a fairly mundane business transaction nowadays. In fact, the two leading mail order meteorite houses in the world are located in this country, albeit half a continent apart in both geography and approach. Robert A. Haag lives in Tucson, Arizona. He was the dealer who purchased the Forkers' half of the Peña Blanca. (My wife's grandmother views her half as a heavenly family heirloom and therefore inviolate.)

At the going rate of \$570 an ounce, the complete Peña Blanca represents a cosmic windfall in the millions of dollars.

Haag's main competitor is the husband-and-wife team of Ron and Diane Farrell, who operate the Bethany Trading Company out of their home near New Haven, Connecticut. Whereas Haag, with his long, curly locks, looks like he just stepped off a surfboard, Ron Farrell could have easily stepped out of a corporate board meeting. Haag is hyper, high on meteorites. Farrell shares the enthusiasm, but in a more, shall we say, sedate manner.

The marketers' catalogs reflect the difference in styles. Haag's latest 32-page compendium is heavy on pictures and self-promotion, including a number

ANSEN SEALE



Roxana Catto considers her half of the Peña Blanca Meteorite to be a family heirloom. It won't go on the market.

of black-and-white photographs of the self-titled "Meteorite Man" striking jaunty poses in remote locales. In addition to the raw chunks and slices of various meteorites, priced from 50 cents to \$20 a gram, Haag offers a selection of hand-made meteorite jewelry, books, slides, plaster casts, and even a "Meteorite Recovery Team" T-shirt.

The 16-page Farrell catalog is somewhat more subdued. It offers many of the same specimens, along with jewelry, display stands, a growing number of books, metal detectors, and custom-

made knives that sport blades forged from nickel-iron meteorites. Along the way the Farrells throw in some educational material.

Whatever their stylistic differences, Haag and the Farrells share a legacy: that of Harvey Nininger, an Oklahoma-born biologist who switched careers at the age of 36 after witnessing a spectacular fireball on November 9, 1923. By the time he died at the age of 99, Nininger had produced several popular books and more than 160 scientific papers about meteorites. An indefatigable public educator and meteorite chaser, Nininger was personally responsible for the recovery of more specimens than anyone before or since. Where others were content with the material initially recovered after a fall, Nininger, sleeves rolled, went into the field and routinely returned with 10 to 20 times that amount. He would enlist the public in the search for specimens, placing ads in local papers and going door to door, samples in hand, prodding farmers to look for similar stones and irons. Nininger also realized that his results were likely to improve if he offered financial rewards.

Haag is clearly indebted to his predecessor. He has traveled around the world to collect his meteorites. Once at a site, the first thing he does is hire a translator, if needed, then enlist the locals, spelling out precisely what he's prepared to pay for specimens. His travels have landed him in a few jams and close scrapes, usually involving bureaucratic red tape in other countries.

One close scrape took place during an expedition to Argentina in January. Haag made the trip to recover the 37-ton Chaco Meteorite, after an Argentine native agreed to handle negotiations with the owner, as well as the rental of trucks and a mobile crane. "Everything was set," Haag says. "We had it on the truck. When we got to the state border we weren't allowed to leave Chaco." It turned out, Haag says, that "the guy who made all the connections never even talked to the owner of the meteorite."

Haag, photographer Jeff Smith, and the Argentine contact ended up in jail; the meteorite went back to its original location. The Americans were allowed home only after posting a \$20,000 bond,

which Haag is willing to forfeit. "I'm not going back," he says. "I won't be able to go back to Argentina ever again, but I won't lose any sleep over it."

Another time, Haag was about to board an airplane in one country with his documented meteorite already loaded. "I had university permits, government permission, export and import papers in triplicate, the whole schmeer, but this one customs official kept balking while the line built up behind me. Once I realized what language we were talking, I handed him every piece of money I had on me. I even threw in my watch, but I got on that plane and I got out with what I came for. That's why they call me the Meteorite Man. I'll do whatever it takes to get my meteorite."

The Meteorite Man was born 33 years ago in Arizona, where his parents ran a rock and gem business. Around the age of 12 he spotted a fireball in the sky during a family fishing trip in Mexico. "I didn't know anything about meteorites," he says, "or whether this even was one. For all I knew it could have been incoming debris from one of our own satellites." Although a search for pieces of the object proved futile, the seeds for his career had been sown.

After college, Haag, then an exploration geologist for an oil company, fell into the meteorite business literally by accident. While recovering from a hang glider crash, he began placing want ads for meteorites in local newspapers. One of the first respondents offered up a chunk of the Canyon Diablo, the giant object that slammed to Earth over 25,000 years ago, gouging out the nearly mile-wide crater east of Flagstaff, Arizona. Although most of the object had vaporized prior to impact, more than 30 tons of fragments have since been recovered, making the Canyon Diablo one of the world's most common—and least expensive—meteorites. "I offered the guy \$500 for it," says Haag, "which shows you how naive I was. Fortunately, he only took a hundred."

At first he only intended to own his own meteorite, but after Haag began displaying his prize at the rock and gem shows his parents attended he received escalating offers. When he received one he couldn't refuse, Robert A. Haag Meteorites was born. "I suddenly realized that there were a lot of other people out



there just like me, with the same interest in this stuff," he says.

A decade later, Haag's mail order meteorites have blossomed into a \$500,000-a-year enterprise, with 3,000 customers worldwide on file. He employs up to eight full- and part-time employees, depending on the need. He predicts he'll break the magic million mark in sales this year. His private collection is already valued at that much. Guarded in a custom-built, temperature- and humidity-controlled vault with a steel door and combination lock, it resides downstairs in his split-level home in Tucson's exclusive Rancho del Cierro Estates.

One of the crown jewels of the Haag collection is a slice of the Peña Blanca. After four years of negotiations, Haag finally purchased the Forkers' 104-pound portion last spring for \$62,000. (Both Haag and the Farrells had hoped to buy the Peña Blanca when it went on

sale, and the fact that Haag got it has proved to be a bone of contention. Ron Farrell, who now refuses to talk about the issue, has said that initially he, Haag, and a third party had agreed to divide the meteorite up equally once it went on sale; Haag denies that any such agreement was made.) Haag still has 50 pounds. Within a few months he had sold the rest to private collectors, institutions, and wholesalers. The Meteorite Man's livelihood depends on just such rapid turnaround. The proceeds fund a never-ending quest for more exotic material, usually obtained from exotic places. In fact, Haag is just back from Namibia, in southern Africa, having obtained a piece of the long-known Gibeon Iron.

Haag leads me downstairs. In the garage of the house that meteorites bought, next to a 1987 Corvette convertible, squats the misshapen mass of

Robert Haag, "the Meteorite Man," counts among his adventures a stint in an Argentine jail.

Haag's Gibeon. It looks like a big baked potato, albeit one made of almost pure iron. Barely a sixteenth the size of the Corvette, the Gibeon weighs a third as much, tipping the scales at 1,060 pounds.

"It took five Nama tribesmen five donkeys and three days to get it out of the hills where it was found and down to the train station," Haag says. From there it was loaded into a 55-gallon drum and shipped 200 miles north to Windhoek, Namibia's capital, then flown to the United States. The airline's lading bill alone came to \$3,700, but Haag insists he could place a telephone call to Tokyo tomorrow and turn a tidy profit by noon. (And in fact, within a few

months Haag will have sold the Gibeon for \$100,000. Replacing it as the largest meteorite in private hands will be Haag's latest treasure, the 5,000-pound Mundrabilla from Australia.)

Haag kneels beside the Gibeon and strikes it with one of his rings, the gold one with the stone from the Canyon Diablo. The Gibeon gives back a high-pitched ping, like a celestial tuning fork. "Hear that ring?" he rhapsodizes. "That's because it's solid crystal, end to end." He points out other telltale clues that distinguish iron meteorites from Earthly iron-bearing ores. "The most obvious indication," he says, "is weight." Irons like the Gibeon usually heft out at 450 pounds per cubic foot. Many are the irons discovered by stubbed toe or farmer's plow.

"But see this?" Haag continues.

For Diane and Ron Farrell, the meteorite business is not just a job, it's a way to relax.

"These are what we call thumbprints." Pockmarking the surface of the Gibeon, like thumbprints in a lump of clay, are numerous elongated shallow depressions that formed when the meteorite partially melted while passing through our atmosphere. "Earth rocks don't display it," he says. Another meteorite identifier is fusion crust. "If you were to break off a piece of this you'd find a thin, dark crust caused by entry," Haag says. "The inner material would be considerably lighter." When irons like the Gibeon are sliced with carborundum or diamond-tipped saws, their interiors reveal a distinctive crystalline latticework known as Widmanstätten patterns, after the 19th century Viennese scientist who discovered them. For the silvery traces to stand out, however, the revealed surface must be highly polished and then etched with diluted hydrochloric acid.

The great majority of meteorites are assumed to be more than four billion years old and to have originated as small

planetary bodies between Mars and Jupiter, the site of the asteroid belt. They come in three basic varieties—irons (siderites), stony irons (siderolites), and stones (aerolites). The stony specimens are the most difficult to identify. Once a stone falls to Earth, oxidation and weathering begin taking their toll, rendering the meteorite increasingly unnoticeable. Given enough time, some stones disintegrate completely. Gram for gram, then, a stony meteorite like the Peña Blanca is worth more than its iron or stony iron cousins.

Circumstances surrounding a particular fall or find also contribute dramatically to its market value. One fabulous specimen would be from the stones that fell on Nakhla, Egypt, on June 28, 1911. Of the approximately 40 stones that fell that morning, one reportedly killed a dog. The Nakhla stones are thought to have been blasted from the planet Mars. Less than half a pound of the Nakhla is known to exist today, but Haag hopes to find more. He has been to the area, 40

WILLIAM HUBBELL





*On the evening of November 9, 1982, Roberta and Wanda Donahue of Wethersfield, Connecticut, were home watching "M*A*S*H" when they received a visitor from outer space. They later donated the six-pound meteorite to the Peabody Museum. It was named the Wethersfield Meteorite II because it was the second to strike the town; the first had arrived 11 years earlier.*

miles outside Alexandria on the Nile delta, three times without success. He likens the venture to "stepping back 2,000 years to the time of Christ," where farmers draw water with ox-driven pumps. He plans to go back this year, armed with illustrated brochures in Arabic.

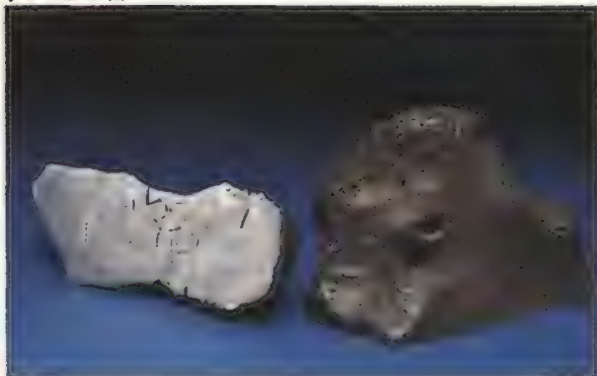
Others who depend on meteorites for their livelihood—the museum curators around the country—view the successes of the meteorite brokers as a mixed blessing. "They make meteorites available that wouldn't be available otherwise," says one curator who deals with Haag and prefers to remain unidentified. "But they're also running prices to ultra-high levels."

Says another curator, who also prefers to remain anonymous ("I want to be on the good side of these people," he says), "Meteorites are an important commodity and they're going to be traded on the world market. There are rare and important samples that have a lot to tell us, and I hope that they don't disappear on the market. For other meteorites there are tons and tons of stuff and they're not so important."

Halfway across the country, in the Connecticut home of Ron and Diane Farrell, meteorite collecting takes on more of the air of a genteel hobby, as if the meteorites discreetly displayed throughout their fastidious home in tiny Bethany were mutant mushrooms from space, cultivated behind glass in controlled light and heat. Ron Farrell's first meteorite, glistening with mineral oil that protects it against the Connecticut humidity, is a double-fist-size clump of



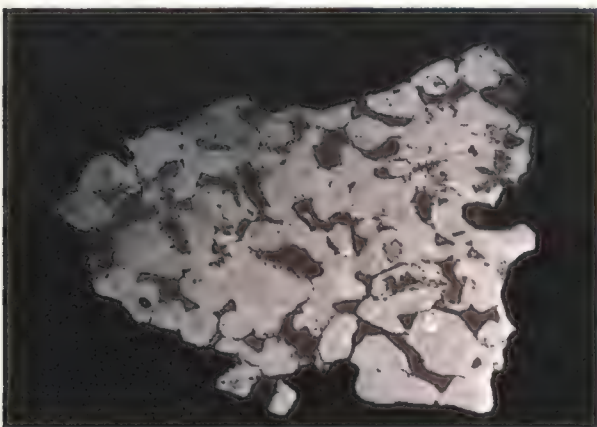
J.W. SMITH (6)



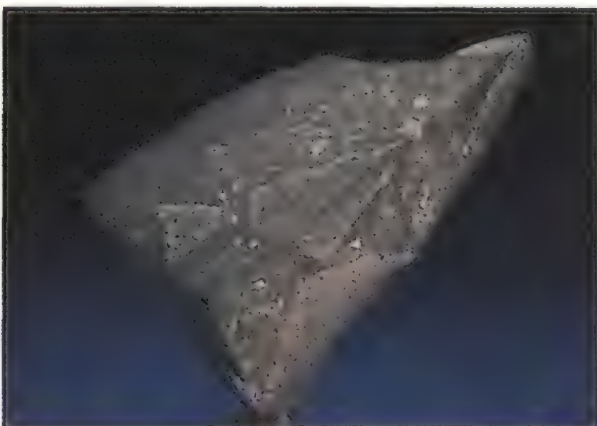
Atacama Desert, Chile



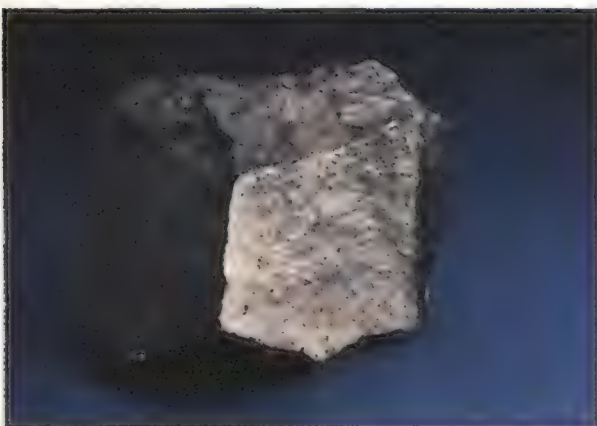
Twannburg, Switzerland



Mundrabilla, West Australia



Abee, Canada



La Criolla, Argentina



Meteorites come in three basic varieties, but dealers use diamond-tipped saws and acid solutions to bring out their individuality. Iron specimens, like the top three, are recovered most often because stony specimens weather away quickly.

Canyon Diablo iron that graces the mantelpiece.

"Haag has to collect," explains Farrell, 34. "That's how he makes his living. I don't." In the Farrells' case, home and car—ironically, another Corvette—were paid for by Ron's daytime job as a design engineer in charge of foreign configurations for Sikorsky Aircraft in Stratford. Meteorites, says Farrell, are a way of winding down from the pressures of the daily routine, even though the demands of the mail order business occupy him and Diane until 10 p.m. or later most weeknights. "Let's face it," he says, "you've seen one helicopter, you've seen them all. I never quite feel that way about these things."

Like Haag, Farrell first became fascinated with meteorites when he saw a fireball streaking across the sky. A subsequent field trip to the Peabody Museum of Natural History on the Yale campus only fueled his interest—and frustration. "I was impressed by the meteorites, of course," Farrell recalls, "but what I remember even more was that you couldn't touch anything. Everything was behind glass."

Farrell admits, like Haag, to being a child of the Soviet-U.S. space race. "The '60s, the Apollo program, walking on the moon... those were exciting times to be growing up, to have your

desires formulated," he says. "If I could go into space I would, but I can't. This way, though, I can at least handle a piece of it. That's closer than most of us ever get." Farrell, like his rival, also quickly learned he wasn't alone. He credits Haag with an early helping hand, along with Glenn and Margaret Huss of Denver, the latter the daughter of Harvey Nininger.

Just entering its fourth year, the Farrells' mailing list includes almost 7,000 customers and is presently being computerized. But Farrell sees himself as more than a salesman: he sees his role as almost a mission. At least 30 times a year he delivers a slide lecture to schools and amateur astronomy societies across the country. He is also at work on a book about meteorites aimed at the layman ("There isn't a good general work currently in circulation," he says) and is in the midst of negotiations with a consortium of European planetariums that will distribute the Trading Post catalog as educational material. The program is being sponsored by the Armagh Planetarium in Dublin, Ireland. In addition, Farrell, along with two Connecticut universities, is participating in a research project at the Meteor Crater in Arizona that will increase our knowledge of what happens at Ground Zero when a large meteorite or small asteroid encounters an immovable planet.

Like Haag, Ron and Diane Farrell eventually intend to donate their collection of stones, irons, and stony irons to a prominent public institution where they can be permanently displayed. "There will be one stipulation, however," Farrell advises. "Handling required." —

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Desperately Seeking Lindy

When Charles Lindbergh landed at Le Bourget, the Paris press corps refused to let anything—including the truth—get between them and a good story.

by Kenneth Koyen



NASM

LINDBERGH DOES IT!" trumpeted the *New York Times*.

Charles Augustus Lindbergh's nonstop solo flight across the Atlantic on May 20 and 21, 1927, went off without a hitch. With careful preparation and single-minded determination, the soft-spoken airmail pilot had done his part in creating one of the biggest news stories of the century.

But for the American reporters covering the Paris end of the historic flight, things did not go so smoothly. Skepticism about Lindbergh before his takeoff from New York and unforeseen events after his landing at Paris' Le Bourget airfield turned press coverage into a comedy of errors. Before the night was over, reporters had resorted to fabricating stories in their zeal to break the news of the rapidly unfolding event.

Saturday, May 21, found Myron T. Herrick, the affable, silver-haired American ambassador to France, taking advantage of the splendid springtime weather by attending the French international tennis doubles final in the town of St. Cloud. The match, which pitted the French team against an American one, promised to be the big news of the day for Americans living abroad.

But midway through the games Herrick received word that

Lindbergh's landing at Le Bourget was witnessed by thousands (above), but for the next six hours only a handful of people had access to the flier, whose disappearance maddened American reporters trying to cover his story.

an airplane, probably Lindbergh's, had been sighted over Ireland at 4:00 p.m. The ambassador departed hastily to return to Paris. The American Embassy, with little faith in Lindbergh's chances of crossing the Atlantic, had made no preparations to receive the young flier.

Back in Paris, the pace began to quicken at the *New York Times* foreign bureau and at the French editions and bureaus of the *Chicago Tribune* and the *New York Herald Tribune*, known in Europe as the *Paris Herald*. Reporters and correspondents hustled to prepare for a possible landing at the airfield.

The press was not much more prepared than the ambassador. Five weeks earlier, the *New York Times* had run a front-page story about the proposed transatlantic flights of U.S. Navy pilots Richard E. Byrd and Noel Davis. Buried back on page 24 was a small item headlined "Third Attempt to Fly Ocean To Be That of Air Mail Pilot."



Lindbergh's autograph was now a worthy prize, but his new nickname was not. The flier detested "Lucky Lindy."



The paper later made up for its oversight by getting Lindbergh to agree to give the *Times* an exclusive first-person account of his feat, provided he accomplish it. Editors at the *Times'* New York office had cabled Edwin James, the paper's chief correspondent in Paris, about the arrangement. "Have just purchased world news rights to Lindbergh flight," the cable read. "... Lindbergh instructed silence except to Times correspondent bearing your credentials. Prepare to isolate him if he's successful..."

Over at the *Chicago Tribune's* Paris office, Waverley Root, a young reporter who had been with the paper for less than two weeks, arrived to find the room buzzing with talk of Lindbergh's takeoff. "Who's Lindbergh?" he asked. No one seemed surprised by his question. Root later wrote in his autobiography, "By not knowing who Lindbergh was at 11:00 a.m. on May 21, 1927, I betrayed the fact that as a newspaperman I was being grossly overpaid at \$15 a week."

By early evening reporters began assembling at Le Bourget. James of the *Times* was on hand with five assistants. Among the many *Herald* men on the field was Wilbur Forrest,

who had positioned himself on the second floor of a building near the terminal. The *Herald Tribune's* bureau chief, Forrest had been in France nine years but still spoke terrible French. An avid golfer, he always managed to bring any conversation back to his game.

Rounding out the field was the *Chicago Tribune's* young city editor Jules Frantz. Grossly underestimating the impact of Lindbergh's possible achievement, Bernhard Ragner, the managing editor of the *Tribune's* Paris edition, did not think it was necessary to dispatch more than one reporter to Le Bourget. The *Tribune's* cub reporter, 23-year-old William L. Shirer, had been covering the tennis tournament, but on the day before the landing he had asked Ragner if he could help cover the arrival. "Sure," said Ragner. "But you have to cover the tennis first."

Soon after six o'clock on Saturday, Lindbergh was sighted over Plymouth, England.

Hank Wales, the raspy-voiced chief of the *Tribune's* Paris bureau, sensed that he might be about to cover the biggest story of his career. Unswayed by Ragner's indifference, he headed out to the airfield. He and his assistant Jay Allen took young Shirer with them as they set out for Le Bourget. They hailed a taxi but found the narrow two-lane road to the airfield jammed with hundreds of vehicles. Every Frenchman with wheels seemed to converge on the four miles of road. After inching two miles through the traffic, the three newsmen got out and walked to the airfield's terminal.

At ten o'clock there was still no Lindbergh. People feared that his 450 gallons of fuel would soon run out. At last the crowd heard the sound of an approaching motor. A small airplane appeared overhead, caught in a searchlight. It was the *Spirit of St. Louis*. The wheels of the single-engine Ryan monoplane finally touched down on the grass at either 10:21, 10:22, or 10:24 p.m., depending on which newspaper you read. (Lindbergh's own log gives a time of 10:22.)

The thousands of excited spectators immediately broke

Ambassador Herrick (right) guided Lindbergh—who spoke little French—through a meeting with France's president.

NASM





down barriers and swept aside police lines. Caught in the tumult, reporters struggled unsuccessfully to reach Lindbergh as the delirious crowd engulfed his airplane. After a few minutes the flier emerged from the cockpit and disappeared into the mass of bodies. Eventually a tall blond man holding an aviator's helmet was borne aloft by the crowd and carried to the administration building where Ambassador Herrick and a reception committee awaited.

The trouble was, the tall blond man was not Lindbergh. He was an American, all right, but not the flier. When the beaming ambassador attempted to embrace him and hand him a bouquet of red roses, the young man protested fiercely, "I am not Lindbergh!"

"Of course you are," said Herrick, still thrusting out the roses.

"I tell you, sir, I'm not Lindbergh," he insisted. "My name is Harry Wheeler. Everyone got confused because of this." He then held up Lindbergh's helmet, which he had snatched during the excitement.

Despite the fact that reporters had not met with or spoken a single word to Lindbergh, they proceeded to file stories that detailed the flier's every word and act. Young reporter Shirer—who would go on to write *Berlin Diary* and *The Rise and Fall of the Third Reich*—was amazed to discover the liberties reporters sometimes took in their stories. He later wrote in his memoirs, "It was surprising, too, at least to a cub like me, that the foreign correspondents had put so much trust in their imagination." For the *Herald Tribune's* lead story the next morning Forrest wrote: "Borne into the offices of the airport, Lindbergh was greeted by the American Ambassador, Myron T. Herrick, and among the flyer's first words were:

Excited spectators filled every nook and cranny at the airfield, creating chaos for news-hungry reporters.

'Well, I did it' Two reporters of The Paris Herald were among the first to reach the side of Lindbergh's plane as it came to a stop on the field. As the machine came to a halt they clambered to the flyer's side The newspaper men grasped his arms and helped lift him from the cockpit to carry him toward the Le Bourget administration building Although worn by his ordeal, Lindbergh smiled and waved at the crowd from a window of the building"

According to the Associated Press, "Lindbergh, bleary-eyed . . . got up from his seat . . . and in a nasal voice, almost drowned out by the crowd, said with charming simplicity, 'Well, here we are' After a battle with the mob, the reception committee got Lindbergh into the Administration Building, where he was officially greeted by Ambassador Herrick and high French officers."

What actually happened to Lindbergh after he left his air-

WIDE WORLD PHOTOS



Correspondent Wilbur Forrest was not afraid to embellish the truth in his haste to file a story.

NEW YORK, SUNDAY, MAY 22, 1927.



CROWD ROARS THUNDEROUS WELCOME

Breaks Through Lines of Soldiers and Police and Surging to Plane Lifts Weary Flier from His Cockpit

AVIATORS SAVE HIM FROM FRENZIED MOB OF 100,000

Paris Boulevards Ring With Celebration After Day and Night Watch—American Flag Is Called For and Wildly Acclaimed.

By EDWIN L. JAMES.

Copyright, 1927, by The New York Times Company. Special Cable to The New York Times.

PARIS, May 21.—Lindbergh did it. Twenty minutes after 10 o'clock tonight suddenly and softly there slipped out of the darkness a gray-white airplane as 25,000 pairs of eyes strained toward it. At 10:24 the Spirit of St. Louis landed and lines of soldiers, ranks of policemen and stout steel fences went down before a mad rush as irresistible as the tides of the ocean. "Well, I made it," smiled Lindbergh, as the little white monoplane came to a halt in the middle of the field and the first vanguard reached the plane. Lindbergh made a move to jump out. Twenty hands reached for him and lifted him out as if he were a baby. Several thousands in a minute were around the plane. Thousands more broke the barriers of iron rails round the field, cheering wildly.

Lifted From His Cockpit.

As he was lifted to the ground Lindbergh was pale and with his hair unkempt, he looked completely worn out. He had strength enough, however, to smile, and waved his hand to the crowd. Soldiers with fixed bayonets were unable to keep back the crowd.

United States Ambassador Herrick was among the first to welcome and congratulate the hero.

A NEW YORK TIMES man was one of the first to reach the machine after its graceful descent to the field. Those minds for the future that will live in the cap off, b'

LINDBERGH TRIUMPH THRILLS COOLIDGE

President Cables Praise to "Heroic Flier" and Concern for Nungesser and Coli.

CAPITAL THROBS WITH JOY

Kellogg, New, MacNider, Patrick and Many More Join in Paying Tribute to Daring Youth.

Special to The New York Times.

WASHINGTON, May 21.—The triumph of Captain Charles A. Lindbergh in flying from New York to Paris without a stop created a tremendous sensation in the national capital and found immediate response in a host of official messages and statements congratulating the daring aviator upon his achievement. President Coolidge expressed his admiration in a message transmitted through Ambassador Herrick in Paris.

plane? In his books *We*, published that year, and *The Spirit of St. Louis*, published in 1953, Lindbergh wrote that his first words in Paris were the pragmatic "Are there any mechanics here?" After he emerged from his airplane two French pilots rescued him from the crowd when its attention was diverted by unwilling decoy Harry Wheeler. Anticipating his fatigue, the pilots took the young aviator by car to a nearby hangar. After resting a bit, Lindbergh was moved to a military officer's private quarters where he finally met Ambassador Herrick. Lindbergh reported that he gladly accepted Herrick's offer to stay at the American Embassy but first wanted to check on his airplane, which he feared had been ravaged by souvenir hunters. Afterwards Lindbergh was unable to meet up with Herrick among the thousands still clogging the airfield.

The pandemonium at Le Bourget gave the press trouble as well. Reporters were unable to find telephones to call in their stories, and getting back to Paris presented difficulties of its own. The enterprising Forrest bypassed the huge traffic jam leaving the airfield by driving his car over the road's curb. He later wrote in his memoirs, "My most difficult period came when I ran into a sidewalk café still in operation. The situation resolved itself into bribing the proprietor to remove the chairs and tables."

The *Herald's* star reporter, John Pickering, ended up abandoning his car and running three miles back to Paris in order to meet his deadline. He stumbled into the office and told the

paper's managing editor: "Damn little story, boss. Never could get a word with him . . . I practically had my hands on him. Then, presto! He's gone. First guy to fly it, and not a single word from him. We're high and dry."

With Lindbergh nowhere to be found, Edwin James and his posse of *Timesmen* realized that getting an exclusive story from him was increasingly unlikely. "Say," remarked James' assistant, Carlyle MacDonald, "I wish the editor who sent that message had been here to isolate him. That's what I wish."

And over at the *Tribune*, Ragner was still playing down the story's impact. When reporter Frantz returned to the office, Ragner told him it was too late to write a story. Frantz was appalled by Ragner's lack of enthusiasm. "Three columns?" he protested when he saw the headline of Shirer's piece. "Every paper in the world will put a banner on this story!"

"What for?" said Ragner. "He landed. We've got the story. That's all there is to it."

While the press hunted frantically for Lindbergh, the exhausted flier was chauffeured into Paris by the French pilots who had rescued him from his airplane. By taking back roads, the Frenchmen avoided the hundreds of cars trying to leave the airfield and delivered Lindbergh to the American Embassy well ahead of Herrick.

Sometime after midnight, the startled embassy staff took him in and installed him in a second floor bedroom. Since the embassy was a logical place for Lindbergh to be, newsmen telephoned there and some actually came to the gate to ask where he was. They were told that Lindbergh wasn't there.

Frustrated by a night of chaos and unable to find Lindbergh, most reporters were ready to admit defeat. But the persistence of one man, the *Herald's* Ralph Barnes, kept the hunt alive. The 28-year-old Barnes, a recent addition to the paper's night copy desk, was regarded as an earnest newcomer by the *Herald's* seasoned newsmen, who sometimes spent as much time at nearby bars as they did reporting. Barnes' pockets were always loaded with books and notes, and he was constantly knocking things off desks as he walked by.

Barnes, who had reported only one story in his brief career at the *Herald*, was fired up to take part in the historic event. "If he's in Paris he can be found," he said of Lindbergh. "Give me some taxi money. I want to go out and try." Barnes went straight to the American Embassy but never made it past the gate. He was back at the *Herald* office in 30 minutes to get more money. Before going to the embassy for a second try, Barnes stopped by the Hotel Continental bar, where most of the American reporters were having a drink before quitting the story. It was past 2 a.m. but Barnes insisted that Lindbergh was at the embassy, and a dozen reporters decided to go back with him.

The press pack rolled up to the embassy in taxis. Once again the concierge refused admission, so Barnes suggested sending their business cards in to the ambassador.

Herrick, who had just made it back from the airfield, reluctantly agreed to see them. In a reception room at the foot of a grand stairway Herrick admitted that the flier was there, but went on to say that Lindbergh needed sleep and shouldn't be disturbed. "But, Golly Moses, Mr. Ambassador!" protested Barnes.



NASM

At that point the telephone rang. It was a reporter from the Associated Press. The ambassador told him there would be no interview until morning.

As Herrick hung up his son came downstairs to report that Lindbergh was awake (perhaps awakened by the commotion below) and ready to face the press. The courtly ambassador was nearly mowed down as Barnes led the charge up the stairs.

Lindbergh, in borrowed pajamas, was sitting on the edge of his bed. The first thing he said was, "Is the *New York Times* man here?" The other reporters glowered. Sensing that he might be in danger of bodily harm if he tried to insist on exclusive access, the *Times*' Carlyle MacDonald identified himself but acquiesced to a group interview. Lindbergh talked and answered questions for about a quarter of an hour. The newsmen then dashed for telephones or hustled back to their offices.

Back at the *Herald*, Barnes walked into the office too excited to speak. It was getting late to file copy, even for New York, which was five hours behind Paris. Nonetheless, editors pushed Barnes into a chair and placed him before a typewriter. "I don't know what to say," said Barnes. "Give me a chance to organize my notes. I can't think." "Write!" shouted the night editor. "Never mind the notes. Just knock it out like he said it. Hurry up. Get it on the paper." As Barnes reached for his voluminous notes, deskmen yanked them away. Finally, he began to peck hesitantly at the typewriter, saving the day for himself and his newspaper. As Barnes wrote, the copy was snatched from his typewriter, paragraph by paragraph.

There have been several versions, some varying widely, of that early-morning interview. James wrote in the *Times*: "Off Mac [Carlyle MacDonald] went and found Captain Lindbergh sitting on the edge of a bed in the Embassy drinking a glass of milk . . . Mac came back, all proud of himself." Readers might

In the days following his flight, Lindbergh—now a world-famous celebrity—drew ecstatic crowds wherever he went.

well have thought that MacDonald, all by himself, found and interviewed Lindbergh. And Hank Wales, who never did find Lindbergh at the airfield, nonetheless filed a story telling Chicago readers of a dramatic airfield meeting between himself and the flier: "'Am I in Paris?' were the pilot's first words . . . 'You're here,' I told him, as the mob jabbered in French . . ." When Wales' assistant, Jay Allen, turned in his account of the actual group interview at the embassy, Wales ran it under his own byline, prefacing it with "Capt. Lindbergh received me in the bedroom in his pajamas, sitting on the bed, when I arrived to deliver his mother's telegram of congratulations." Wales even received a \$500 bonus from the *Tribune*'s publisher for his "scoop." Never had so many exclusive stories emerged from a single interview.

The six hours that followed Lindbergh's landing were more eventful for the press—and almost certainly for the flier—than any of his 33½ in the air. Although the night finally ended for Lindbergh after 4:00 a.m., his lifelong relationship with the press had just begun. Only a day before he had been an airmail pilot from St. Louis. Now he was the focus of the world's attention.

Later the same day the 25-year-old flier faced his first formal press conference. He descended the embassy stairs with one arm grasped by Herrick and the other by a representative of the Ryan airplane company. "What do you think of Parisian women?" one reporter asked. "I haven't seen any yet," replied Lindbergh. Then Hank Wales yelled out in his raspy voice, "Say, Lindy, did you have a crapper on that plane?" The young flier made no reply.

So began Lindbergh's first day of celebrity. ➤



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Chairman of the Board & CEO
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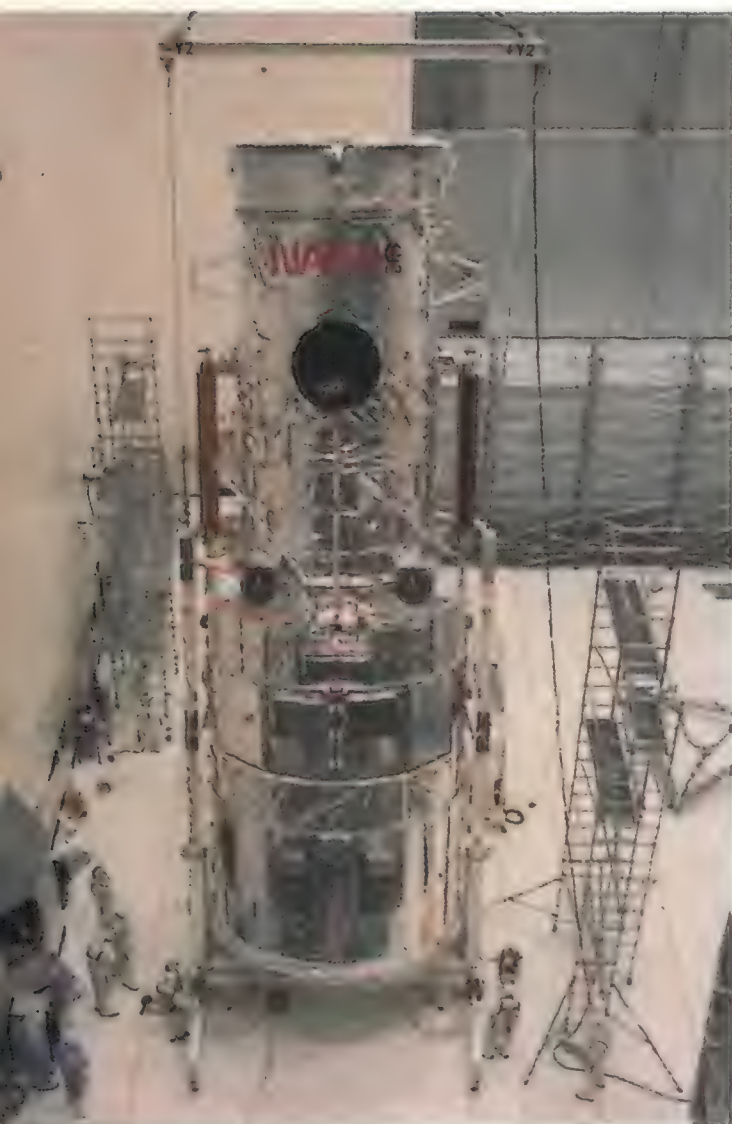
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First Light for the Hubble

The astronomers who get first crack at the space telescope are on the lookout for black holes, missing matter, new solar systems—and that's just for starters.

by George Greenstein



The Hubble Space Telescope is hoisted up during launch preparations at Kennedy Space Center in Florida (above). Once the shuttle has deployed it into low Earth orbit (right), the telescope will be able to view 97 percent of the known universe.

It weighs in at a little under 13 tons, and at a final cost of close to \$4,000 an ounce, it is many times more precious than gold. The Hubble Space Telescope is, in fact, the most valuable astronomical instrument ever made. No other telescope we possess remotely approaches it in terms of the view of the sky it will afford.

Named in honor of Edwin Hubble, the great astronomer who discovered that the universe is expanding, the instrument has magnificent optical properties: its resolution is up to 30 times that of most ground telescopes, and it is capable of detecting objects 50 times fainter than those visible from Earth. If it were set up in Washington, D.C., it could make out the hair color of a person in California, or discern the headlines of a newspaper in Massachusetts.

Optics this fine would be wasted on a ground-based telescope, however. Our atmosphere is pocked with minute distortions, and when light from distant objects passes through them, it fluctuates slightly. When we gaze at stars with the naked eye we perceive these fluctuations as twinkling; when we peer through ground-based telescopes, objects seem blurred. This blurring is universal, and nothing can be done to avoid it—nothing, that is, from the ground. Which is why the Hubble telescope, if deployed on schedule, will take up residence this spring in an orbit 380 miles above Earth, outside of the distorting atmosphere.

Six scientific instruments will be on board the space telescope: two cameras, which can photograph everything from nearby planets to distant quasars; two spectrographs, which will break up the light from astronomical objects into its

constituent colors; a photometer, which can detect ultra-rapid fluctuations in the brightness of incoming light; and a fine guidance system, designed to point the telescope but also potentially useful for making astronomical observations. All the instruments are modular, so as technology improves, they can be replaced during visits from space shuttles.

Because the Hubble telescope is public property, every astronomer can apply for time with it. Competition so far has been intense: for the instrument's first 1,200 hours of observation time, scientists offered up some 11,000 hours' worth of proposed observations. Each proposal is reviewed by one of six scientific panels covering various disciplines of astronomy; accepted proposals are classified as either high-priority or standby.

But during the first year, most of the observations will be conducted by the so-called Guaranteed Time Observers. These are the astronomers who have been most closely involved with the Hubble Space Telescope project over the years; it is they who will have the historic opportunity to conduct the first observations with it—observations that may one day prove momentous.

James Westphal never had any formal training in astronomy. He never even got a Ph.D. Instead, after getting a bachelor's degree in physics, he went to work as a geophysicist for Sinclair Oil. One day he got in touch with a geology professor whose work he was pursuing. The geologist, at the California Institute of Technology in Pasadena, invited Westphal to visit Caltech for a few months. He never did get around to leaving.



Westphal's great skill is building scientific equipment. He'd been an amateur astronomer as a boy, and at Caltech he soon took to building equipment for telescopes. Bit by bit he started to use the equipment himself. He began by observing planets, but soon turned his marvelous gadgets on stars.

One day his friend and colleague James Gunn wandered into his office and told Westphal that they had to get involved in the space telescope project. "I said, 'Jim, that's not our kind of thing,'" Westphal recalls. "'That's NASA, that's a big mess. It's not our style.'" "I know," Gunn replied, "but if we don't, we're not going to be in astronomy ten years from now."

The instrument that Westphal, Gunn, and their colleagues built is the Wide Field/Planetary Camera, known in the trade as the "Wifpik." It is likely to be the most widely employed of all the Hubble's instruments. The Wifpik can be operated two ways: in a normal wide-field mode, and in a special high-resolution mode originally designed for plane-

tary work. Among other things, Westphal wants to use his camera to photograph Jupiter's Great Red Spot.

Since its discovery more than 300 years ago, the spot has been one of the most enigmatic features in the solar system. Larger than the entire planet Earth, it seemed at first to be some dark blemish on Jupiter's surface. Astronomers quickly realized, however, that the actual situation was a good deal more mysterious: the red spot continually fluctuated in size, shape, and even color. The Voyager flybys of Jupiter in 1979 added crucial information to the puzzle. The spectacular photographs they sent back revealed the spot to be a gigantic vortex—a hurricane.

Perhaps the strangest aspect of this hurricane is its permanence. Storms on Earth die out relatively rapidly; this one, however, has been raging for hundreds of years. Westphal would like more precise information on this point. Among other things, he would like to determine if the spot is either dying out or growing stronger. For these observations, he

will make use of the space telescope's long lifetime in orbit. The photographs it obtains of the planets will not quite rival the best obtained by the Voyagers, but the Hubble telescope will be able to photograph Jupiter again and again over a period of some 15 years.

In perhaps the greatest surprise of their odyssey, the Voyagers discovered that the surface of Io, one of Jupiter's moons, is peppered with volcanos. When the probes swept by, about a dozen were active, almost continually spewing clouds of sulfur dioxide hundreds of miles upward. Are these volcanos permanent features of Io? Or does each die out, only to be replaced by another? More than a decade after their discovery, Westphal will photograph them to determine which remain.

The task of obtaining these images will not be as easy as it sounds. To photograph Io from the ground, one simply points a telescope at the satellite and exposes the film. But because the space telescope is so accurate, the motions of Io—and of the telescope itself—will

ASTRONOMICAL SOCIETY OF THE PACIFIC



Competition for time with the telescope's six instruments is fierce: the first batch of proposed observations outnumbered available hours by more than nine to one.

have to be taken into account during the exposure. The telescope will be orbiting Earth, Io will be orbiting Jupiter, and Jupiter will be orbiting the sun, so the telescope must compensate with a complex series of maneuvers throughout the observation.

Other observations call for yet more taxing maneuvers. Photographing the planet Mercury is one such challenge. The problem is that Mercury lies very close to the sun, and were the space telescope ever to point directly at the sun, it would be irreparably damaged—blinded. Though the Hubble is equipped with a safety mechanism that shuts it down in the event it is accidentally pointed toward the sun, no one wants to take chances.

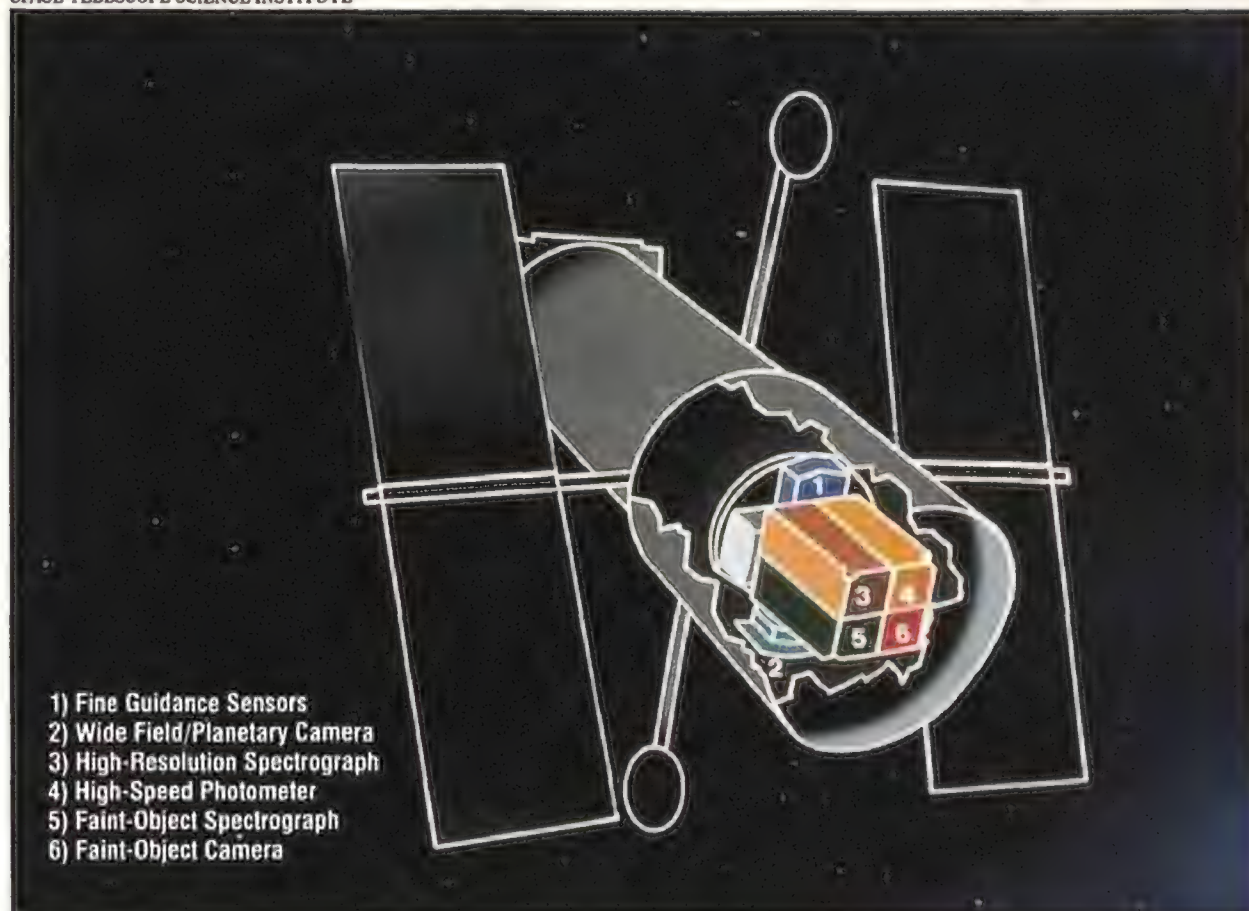
Westphal's plan is to use Earth as a shield to protect the telescope from the sun during the observation. He intends to begin by pointing the telescope toward Mercury when both it and the sun

James Westphal's camera may reveal some of the secrets of Jupiter's violent Great Red Spot (opposite).

ERNEST LORENZ/CALTECH



SPACE TELESCOPE SCIENCE INSTITUTE



lie below Earth's horizon, and to track upward as the planet rises. The instant it does, his observation will begin—a single, quick exposure. Westphal has at that moment less than five minutes before the sun rises. As soon as his observation is complete, the telescope will have to start swinging.

Five minutes turns out to yield a sufficient margin of safety. Nevertheless, so audacious is Westphal's maneuver, so horrifying the prospect of error, that the observations of Mercury will not be conducted right away. NASA wants to wait until the engineers controlling the telescope have gained experience in actual, hands-on operations. Of course, NASA does not use terms such as "audacious." Agency officials prefer to describe Westphal's observations as "sporty."

Robert Bless of the University of Wisconsin hadn't wanted to go straight on to graduate school after finishing college. Instead he took a job at the Naval Research Lab in Washington, D.C. It was shortly after the close of World War II; next door to his lab a scientist named Richard Tousey was working with a captured V-2 rocket.

Tousey planned to use the rocket to obtain a spectrum of the sun (see "Richard Tousey and His Beady-Eyed V-2s," June/July 1986). The V-2 was launched into a brief suborbital flight at the White

Sands missile base in New Mexico and fell to earth a few minutes later; the film was retrieved and sent to Washington. There, Bless recalls, "I was called into service, as were all the other young squirts in the vicinity, to help develop it." It was laid out in long trays filled with developer. Everyone stood in the dark, agitating the film with camel's-hair brushes.

When the lights were turned on, the group saw that the film was absolutely black. Apparently the cassette had cracked open when the V-2 crashed. Nevertheless, Bless found the whole thing "pretty nifty," and he has remained in space astronomy ever since.

For the Hubble Space Telescope he led the team that built an entirely new kind of space instrument: the high-speed photometer, which measures ultra-rapid fluctuations in the intensity of light.

It is extremely difficult to conduct from the ground the sort of observations this instrument is designed to perform. The problem is the old one of twinkling induced by our atmosphere. Unfortunately, there is no reliable way to distinguish it from any actual variation of the source itself. The problem has limited all previous searches for brightness variations of celestial objects to relatively slow fluctuations.

The high-speed photometer, on the



"Halo stars," such as that in the center of the rendering at right, are the most distant Milky Way stars visible

from Earth. John Bahcall (above) will use the Hubble to look for stars that ground telescopes can't detect.

other hand, will be able to detect variations in brightness over periods as short as a 1/100,000 of a second. Bless and his team plan to focus the photometer on a star lying directly behind the rings of Saturn and thus learn more about the rings themselves.

Voyager revealed that Saturn's rings are composed of innumerable tiny strands. As Saturn moves along its orbit about the sun, these strands will pass in front of the star, momentarily blocking the star's light. Bless and his team plan to determine the precise pattern of dimming and brightening and from it pro-

duce a detailed map of the strands.

Their map will show only the ring structure along a single line, corresponding to the path of the star behind the rings. It will be like a topographical map of the United States drawn from information obtained on a single cross-country automobile trip. But there are a few other stars lying along Saturn's path across the sky, so a few other slices through the ring system can be obtained each year. Over the course of many years, something of a map of the ring system will be built up. It will be incomplete, but the high-speed



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photometer is so accurate that the map will be 40 times more detailed than that obtained by Voyager.

Bless and his team also plan to use the photometer to hunt for perhaps the most bizarre astronomical objects ever proposed: black holes. According to Einstein's theory of relativity, a star under certain circumstances can catastrophically collapse in upon itself to become an object whose gravitation is so intense it traps light and strains the very fabric of space.

A black hole can act as a cosmic whirlpool, sucking in matter that ventures



too close. When a chunk of material whirls about the hole, it will alternately approach and recede from Earth. As it moves away from us, its light will grow redder and so dim as to be invisible; as it approaches, the light will be bluer and extremely brilliant.

That is the characteristic pattern Bless and his co-workers will be searching for: a sudden *rat-tat-tat* of pulses of light, the light growing bluer as the chunk of matter spirals more rapidly, then suddenly ceasing as the material passes over the edge and is sucked into oblivion. The pattern is unique. If the

researchers find it they will have the firmest evidence yet of the existence of black holes.

Colleagues delight in recounting how Institute for Advanced Study astronomer John Bahcall managed to obtain an uncharacteristically great amount of observing time on one of the world's largest telescopes. Competition for use of the telescope is normally intense, so Bahcall requested it for the week an international meeting of astronomers was taking place. Everyone else went to the meeting, and Bahcall got his time.

Early in the project's history, he turned the same ingenuity toward lobbying for the space telescope. He learned the ins and outs of Washington—why it was important to know what key senators did on weekends, how to get staffers to return his calls. A high school friend set up an appointment with a senator. The mayor of Princeton, New Jersey, got him a meeting with a congresswoman who also happened to be her mother—a meeting that ultimately took place in the lounge of a House women's restroom.

Now, more than a decade later,

Bahcall will be using the space telescope to investigate one of the central mysteries of astrophysics today. The mystery came to attention almost accidentally, the result of what should have been a fairly routine program of research: a study of the orbits of stars in our galaxy. These orbits are bent by the Milky Way's gravity, which in turn is a product of its mass. Surprisingly, this mass turned out to be far greater than anyone

had thought. Somewhere in our galaxy an enormous quantity of unseen matter lurks.

Bahcall will investigate the possibility that this matter is made up of ultra-dim stars. He will do this by using the Wifpik to photograph two regions of the sky, then searching the photographs for the faintest points of light. Such a finding would revolutionize our understanding of the Milky Way. These stars would be

so dim that, were the Earth to orbit one, daylight would be oppressively dark—the constellations would be visible at noon. And to account for the missing mass, these stars would have to outnumber the known ones by ten to one.

There is another, possibly related, mystery Bahcall will investigate with the space telescope—what happens to the light from quasars as it journeys to Earth.

JPL



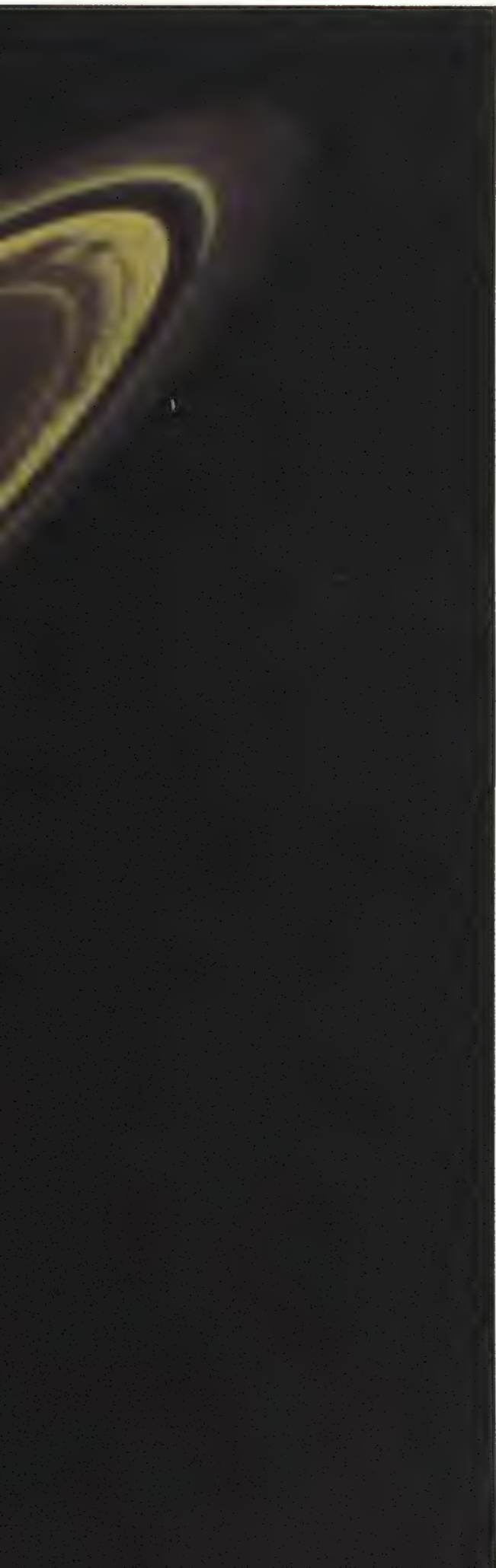


SPACE ASTRONOMY LABORATORY

Robert Bless (at far left, shown with the high-speed photometer) plans to use his instrument to map Saturn's rings. His observations may provide a far more detailed picture than those of Voyager (below left).

A black hole in the process of sucking in matter, depicted in the artist's conception below, would also be a major find for Bless.

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Since they were discovered three decades ago, quasars have been among the most enigmatic objects ever observed by astronomers. Star-like in appearance, they shine with an intensity greater than that of an entire galaxy, and they are shaken by monstrous, poorly understood cataclysms in which they appear to flare and fade erratically. One of the strangest things about quasars is that their spectra suggest that their light is being partially absorbed—and that the absorbing material is situated at enormous distances from the quasars themselves.

A decade ago Bahcall and colleague Lyman Spitzer proposed that the absorbing material might consist of gigantic clouds of gas in which galaxies are embedded. Such clouds have also been targeted as candidates for the galaxy's missing mass.

Bahcall intends to use the space telescope's faint-object spectrograph to obtain spectra of quasars situated behind

the purported clouds. If Bahcall and Spitzer's theory is correct, the spectra will reveal the presence of diffuse gas. The tell-tale spectral features ought to lie in the ultraviolet portion, and because ultraviolet light is almost entirely absorbed by our atmosphere, the Hubble is in the ideal position to make such observations.

At the time of their discovery, quasars were thought to be isolated objects. But more recently, ground-based observations have shown that at least some are located in galaxies. In a parallel project, Bahcall will attempt to determine if all of them are. He hopes to evaluate the hypothesis that the gigantic upheavals of quasars are in some mysterious fashion part and parcel of the evolution of every galaxy, including our own. To test this, he intends to use the Wifpik in the high-resolution mode to photograph the nearby quasars in hopes of detecting their surrounding galaxies, and concurrently to study their

spectra for signs of the stars that make up galaxies.

One of the surprises of the space telescope has been the fact that a system included for purely engineering purposes turns out to have important scientific uses.

So great is the magnification of the telescope, so detailed are the photographs it will obtain, that it must be pointed with extreme accuracy. The slightest error and the telescope will photograph the wrong regions of the sky. This pointing is accomplished by the Fine Guidance Sensors, which will determine the telescope's orientation relative to a set of guide stars. And because this direction must be known to great accuracy, the sensors will determine the location of these stars with pinpoint precision.

William Jefferys of the University of Texas wants to know if any of these guide stars are encircled by planets. Even the space telescope would not be capable of directly photographing any that might exist—they would lie so close to their stars that they would be lost in the glare. Instead, Jefferys, principal investigator for astrometry and scientific advisor to the team that designed the Fine Guidance Sensors, plans to exploit a different technique in his search. It is based on the fact that a planet does not simply orbit a star. Rather, the planet and star make each other move.

The orbital motion of two bodies is analogous to the motion of a father gripping his child's hands and whirling him around in a game of "airplane." While the child is "flying," the father will also move in a circle, albeit a much smaller one. Over the course of a year, the sun slings Earth in a circle 93 million miles in radius—but at the same time, Earth slings the sun in a circle some 600 miles across. Although this motion is tiny by astronomical standards, the Fine Guidance Sensors are so accurate that they will be able to determine if any of the nearby guide stars are also moving in this way.

This search technique has already been used from the ground. Over the years, claims have been made that Barnard's Star, one of our nearest neighbors in the galaxy, possesses planets.

But the observations are so difficult and technically extreme that confirmation of these claims has been impossible. The Hubble's Fine Guidance Sensors should resolve the issue. Barnard's Star is one of 12 that Jefferys and his colleagues will study; so is Proxima Centauri, the closest to our sun.

Their project is not going to yield immediate results. A full year is required for the sun to move in the circle imposed upon it by Earth; more than five years to move in the circle imposed by Jupiter. In order to be sure that he is really seeing orbital motion, Jefferys will require observations over comparable lengths of time.

Colleague Fritz Benedict, on the other hand, needs much less time to get his work done. He plans to search for planets lying exceedingly close to their stars. Such planets should orbit rapidly, and Benedict's observations will be correspondingly brief. He has singled out a particular set of stars that might harbor such planets, and his data should be in hand within a few months of the telescope's deployment.

When James Beggs was the administrator of NASA, he told a congressional subcommittee that the Hubble Space Telescope was the hardest job NASA had ever tackled. Initially planned for launch in 1983, it has been beset by a seemingly endless series of setbacks and postponements. Some of the Guaranteed Time Observers have been with the project since the early 1970s. "There have been so many delays and false alarms," Bob Bless says, "that you would forget why you ever got involved in the first place. This is not the first launch date that I felt was approaching and have had to gear up for, only to be disappointed. And there have been so many disappointments that it's been hard to persuade oneself that it's real. But now there is a change in mental gears. This time it really looks like it's going to happen."

"We're weary," says Jim Westphal, "but we're excited as well If we get a good fraction of what we hope, why it's going to be an awesome bit of science. We're going to learn all manner of things nobody ever thought of, and we're going to have the time of the rest of our lives." ✦

William Jefferys will employ the space telescope's Fine Guidance Sensors to search for other solar systems. The guidance sensors' less glamorous role is to lock on to selected target stars to ensure that the telescope is precisely oriented before it makes its observations (far right).

The Hubble telescope's superb powers of resolution will enable it to examine many binary star systems, such as Kohoutek 1 and 2, portrayed below.

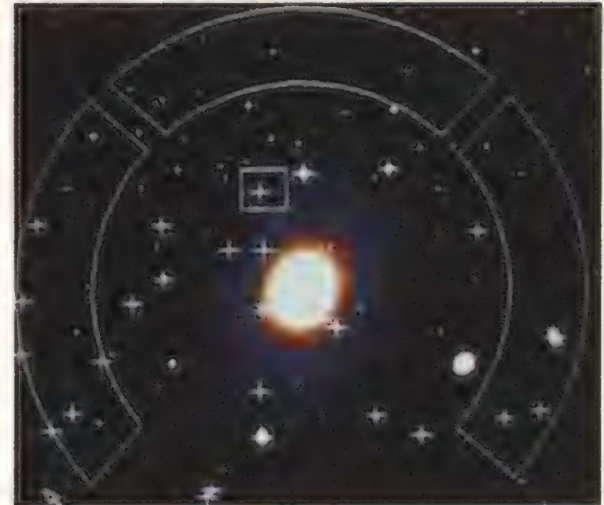
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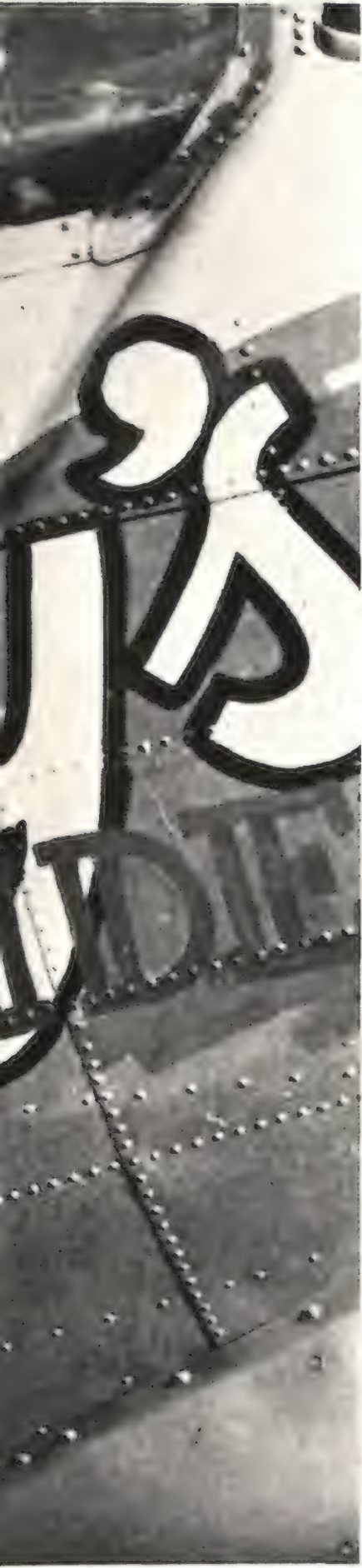
U.S. AIR FORCE MUSEUM



Business

During World War II, fliers elevated the pinup to a new art form.

by Phil Cohan



Jim Jones, a U.S. Air Force lieutenant stationed in West Germany in 1986, could have painted just about anything on the nose of his F-16. But General Chuck Donnelly, then commander of the U.S. Air Forces in Europe, had encouraged his young pilots to resurrect icons from the airplanes flown in previous wars, thinking it would bolster crews' pride in belonging to units that had served with distinction. So Jones chose the art that had adorned his father's F-4 Phantom II, *Sweetie Pie Jones*, in Vietnam.

The original artwork, which featured a redhead reclining in brief swimwear, needed some changes. Not only was the F-16's slender nose less spacious than that of the F-4, the new artwork also had to meet Donnelly's dictates of good taste. "I wanted a good-looking redhead," Jones says, "but everyone felt that she should be wearing more clothes." Jones' crew chief put *Sweetie Pie Jones II* on her feet, clad in a miniskirt.

Jones was continuing a military tradition almost as old as warfare itself. Soldiers of ancient Egypt made handsome carvings in their maces and adorned some of the first

horse-drawn war chariots with paintings. The emblazoned shields and armor of medieval knights grew into a complex system of heraldry. And many American Plains Indians painted both themselves and their horses.

But the art painted on warplanes was a horse of a different color. At its creative peak during World War II, nose art portrayed cartoon and comic strip characters, flags and eagles, Hitler and Eisenhower, charging bulls, scowling dogs, yowling cats, and good-luck symbols. Mostly, though, nose art was girls: Hollywood love goddesses, *Esquire's* Varga Girls, and girlfriends in seductive poses and costumes. World War II artist Ted Simonaitis describes his work as ranging from "the sentimental, the comical, semi-nudes in good taste, and the downright raunchy."

Psychologists say that people at war feel a need to trust—and even feel affection for—their weapons and vehicles. Airmen used nose art to personalize the machines they flew through flak and enemy fighters while loaded with volatile fuel and explosives ("Don't worry—our *Dragon Lady* won't let us down"). Helping to fulfill a diverse mix of psychological needs, nose art was a link to home, a statement of sexual bravado, and a chance to defy authority, albeit harmlessly. Indeed, a tradition arose among American fliers that discouraged the removal of art from

Beautiful women inspired most nose art—some, like Corporal Ruby Newell, more decorously than others.





NASM



Not all art was glamorous: some was as sensible as a sturdy pair of shoes.

Big-nosed bombers like the B-25 were ideal canvases for wartime art (left).

an airplane that had carried a crew safely through battle. A new crew might add to a graphic or a name, but few chose to argue with success.

Though nose art, a wartime morale builder, virtually disappears in peacetime, it is now resurfacing on tankers and bombers, National Guard aircraft, and some fighters based in Europe. But today it is less garish. Only muted colors that do not interfere with the camouflage are allowed, and the art itself, as Jim Jones learned, must be inoffensive. Back in the 1940s, though, nose art offended plenty of people, even if it did accurately reflect the changing times.

During the war years the media began assuming unprecedented influence over American life, and sex appeal proved to be one of its most effective levers. Hollywood became the principal setter of American styles and standards. Stars like Ann Sheridan, Rita Hayworth, Betty Grable, Jane Russell, and Dorothy Lamour became the sex symbols of World War II, posing for pinup photos that featured provocative displays of skin and tight clothing. Circulation of publications like *Life*, *Look*, and *Esquire* skyrocketed with the popularity of their pinups. *Esquire* published special military issues to celebrate the new Varga Girls calendars, created by Alberto Vargas.

In September 1943 the U.S. Post Office challenged *Esquire's* second-class mail privileges, objecting to the magazine's "lascivious matter." The suit, upheld in court

FRANK B. MORMILLO

A classic piece of nose art is all that remains of one B-17 at the Confederate Air Force museum (right).



COURTESY WARREN THOMPSON



Visits from movie stars like Mickey Rooney further bolstered a crew's affection for its aircraft.

in 1944 but overturned the following year, served only to further promote the magazine and its Varga Girls, who became the war's most popular nose art icons.

The aircraft artists generally covered their subjects with a bit of paint here and—maybe—there. But usually the swimsuits or halters were added only at the insistence of base commanders. And the farther a group was from headquarters, the racier its art. "The girls on the [Army Air Forces] planes in England were pretty much covered up," says nose art specialist Melissa Keiser of the National Air and Space Museum, "presumably because they were so close to Command. But when you got way out in the South Pacific they tended to shed more clothing." The art aroused a brouhaha when, late in the war, some airplanes returned to the United States for war bond rallies. Photos ran in magazines and newspapers, and millions of people saw the embellished aircraft. The nudity and occasional obscenity angered many civilians. Commanders reviewed their charges' artwork and sometimes ordered coverups. Some crews grudgingly painted "CENSORED" over their work rather than adding clothing.

Anne Haywood Gordon, a young English-

woman, couldn't figure out what all the fuss was about. She worked for the American Red Cross at Great Ashfield Air Base in East Anglia, where she painted nose art on U.S. bombers and where fliers named a B-17 *Hay-bag Annie* in her honor. After the war Gordon earned a degree in art history from Oxford University. Today she paints at her home near Oxford. She's amused by accusations that nose art was an offense against women or any other group. "Its purpose was worthy, to bolster military morale in a terrible time," she says. "The members of each crew came to feel that their plane and their painting were somehow special and would bring them luck, a safe return from hostile skies. The art may have been frivolous at times, but it was *never* anti-social."

NASM



Most of the artists were enlisted men whose fees ranged from hard currency to a bottle of hard liquor. Engaging a good artist typically cost each member of a bomber crew a few dollars, but many of the painters say they took nothing for their work. Bombers, with their spacious noses and flanks, bore most of the war's art; the limited space on a fighter, with its crew of one, allowed at most a nickname or a small image.

Dick Ayers was an aspiring cartoonist in his late teens when he was assigned as a draftsman to a squadron in the 394th Bomb Group. He remembers getting teased about the nudes he painted on the squadron's B-26s. His buddies claimed that the commanding officer tolerated his sexy art only because the artist seemed like such an innocent kid. Ayers' nose art did include some innocent work, such as the Chinese god of laughter (*Mi Lei Fo*) and a hillbilly with a jug (*Who Cares?*), but he also painted a bikini-clad girl on the run (*Slow*

NASM



If it moves, paint it: wartime art was not confined to aircraft (left).

Art was sometimes highly personal, inspired by mascots, girlfriends, and wives (above and below).

PHILIP MAKANNA





The Two Memphis Belles

Margaret Polk sits at a table in her sunroom leafing through a scrapbook. It is a dreary winter day in Memphis. The backyard swimming pool is covered and the bird feeders are bare. "Those little bastards," she says, looking out the window. "I feed them all winter long and as soon as they start turning pretty, they fly away."

There is a hint of stubbornness in the set of her jaw, but her eyes have a mischievous gleam. As she leafs through the scrapbook it is difficult to recognize her as the 20-year-old girl in the yellowed newspaper clippings. But Margaret Polk, 47 years older and a lifetime wiser now, is the original Memphis Belle.

Margaret was catapulted into the public eye when her fiancé, Captain Robert Morgan, returned to Memphis from the war in England flying "her" B-17, the *Memphis Belle*. Morgan had named it after Margaret, and the city dutifully adopted both the couple and the bomber. Local bigwigs were on hand when it touched down at Memphis Municipal Airport on June 19, 1943, but Margaret was oblivious to the reporters assigned to cover her. When the *Memphis Belle* finally landed on that summer day and Bob Morgan jumped out to sweep Margaret into his arms, the photo of their embrace made the front page of the afternoon paper.

Margaret says that was the happiest day of her life. "All I could think about was that he was coming home and we were going to get married," she says. "But anytime the government gets involved they'll screw

things up. And they wanted a romance, not a marriage." The wedding was postponed.

Margaret had met Bob the previous summer while visiting her sister in Walla Walla, Washington. To Margaret, he was just another pilot stationed at the airbase. But Bob was not to be ignored. Every morning he buzzed her sister's house with his B-17. Weeks later, flattered but not swayed, Margaret drove back to Memphis to finish her senior year at Southwestern University. At home, a letter from Bob was waiting.

"My dearest 'Polky,'" it read. "I miss you 'little one,' I miss you more than you'll ever know or understand . . . I know now that I have never loved before . . . If we can't have OUR LIFE before the war is over I know I shall come to you afterwards, providing you still want me . . . Write soon, 'little one.' I send you all the love in my heart. Forever yours, Bob."

That got her attention. When Bob sent a telegram a few weeks later to say he'd be in Jackson, Mississippi, that evening, Margaret drove all night to spend a few hours with him. They were engaged on September 12. Bob named his new B-17 the *Memphis Belle*, had one of *Esquire's* Petty Girls painted on its nose, and flew off to England. If he had named the bomber *Little One*, as he had originally intended, Margaret's life—and his—might have turned out quite different.

In the last months of 1942 the Allies sustained heavy losses in Europe, and American morale needed a boost. Every little victory made headlines. When the editor of the *Memphis Press-Scimitar* learned that one of the airplanes doing

battle in Europe was named for a local woman, he immediately put a reporter on it. The next day pictures of Margaret and Bob were on the front page. "I about fainted," says Margaret, who came home from school and discovered she was famous.

From then on news about the *Memphis Belle's* victories appeared regularly. Margaret lost some 15 pounds waiting for cables, letters, and news from England. Then, on May 31, she received the cable she'd been waiting for. "SAFE TOUR OF DUTY COMPLETED FINGERS CROSSED ADORE YOU BOB." She started eating again.

As one of the first airplanes to complete its overseas missions and the star of a War Department documentary, the *Memphis Belle* and its crew were selected for a stateside tour. The second stop, after Washington, D.C., was Memphis, where the young couple would be reunited. When the airplane landed, Margaret was escorted to it by an Army Air Forces public relations officer. Quite unwittingly, and without compensation, Margaret had been drafted.

The *Belle* flew on to Nashville and the northeast states. Margaret was flown to Cleveland by Bob's pre-war employer to surprise him. Surprise indeed: he already had a date for the evening. Still, he swept Margaret into his arms for the cameras and insisted they get married on the spot. A store was opened so Margaret could buy a wedding dress, but she declined, envisioning a less frantic ceremony.

Margaret went home to Memphis and the *Belle* flew west. Her scrapbooks are full of newspaper clippings that show women clambering over one another to get an autograph from the handsome pilot of the *Memphis Belle*. She recalled that when Bob was in town, women called her house looking for him. "Some wanted to ask about their brothers who were still overseas," she says. "But some of them just wanted to flirt." She also learned that Bob had already been married.

On August 1, Margaret phoned him at the Brown Palace Hotel in Denver. "I don't remember what made me so mad," she says. "Some woman must have answered the telephone, or she must have come and talked to him while he was talking to me. But something happened." Margaret broke the engagement.

"I was just devastated," she says. "He may have tried to call the next day, but I went over to my friend's house. I remember sitting out on her front porch just crying my heart out."

Margaret also called her Army Air Forces contact. "He said, 'You can't break that engagement.' I said, 'Well, the hell I can't. I've already done it.' He said, 'You hold fire now, I'll get back to you.' Then he called me back and said, 'Well, don't you get it to the newspapers. Let's keep this under cover.' But it was too late."

A small item ran in the August 3 *Memphis Commercial Appeal*: "Wedding Bells Won't Ring Out for Memphis Belle and Flier." Within a week Bob was engaged to a woman in San Antonio. That too made the news, but the romance didn't last. Soon Bob was again begging Margaret to reconsider.

She needed more time, but the war wouldn't wait. By December Bob had a new assignment and a new airplane to fly in the Pacific. He wrote to Margaret and thanked her, on behalf of the whole crew, for allowing them to name the *Memphis Belle* after her. Then he married Dorothy Johnson of Asheville, North Carolina, his hometown. A year later he led the first B-29 raid on Tokyo in a bomber named *Dauntless Dotty*.

Margaret Polk still lives in Memphis, where the restored *Memphis Belle* is on permanent display. She occasionally shows up at the Memphis Belle Pavilion to sign autographs. Often she's asked if she's the girl in the bathing suit perched up there on the nose of the airplane. She's not, but she tells them she is—just to see their "little ol' mouths fall open."

"I'm still crazy about Bob," she says. In the 1950s Margaret married a traveling tractor parts salesman, but the five-year marriage never approached the intensity of the romance she had with Bob, who eventually divorced Johnson and remarried.

Still, Margaret says she and Bob are friends. A recent Christmas card from him reads, "Love bears all things, believes all things, hopes all things, endures all things. Love never ends." It is signed, "Past, present, future—love, Bob." "That Bob," Margaret says, shaking her head. "He could charm a snake."

—Elaine de Man



PHILIP MAKANNA



Starter), a sad and naked angel (*Homesick Angel*), and a nude clutching a bomb under each arm (*Connecticut Yankee*). After the war, Ayers turned to comic books, illustrating *The Human Torch*, *Sergeant Fury and His Howling Commandos*, *The Hulk*, and *The Ghost Rider*.

Much nose art was in fact as innocent as Fearless Fosdick's amiable klutziness. Cartoon characters, particularly Bugs Bunny, were popular, and Walt Disney creations adorned airplanes in every theater of war. (Disney artists produced more than 1,200 designs that served as unit insignias.) Characters from comic strips, such as Al Capp's *Li'l Abner* and Milton Caniff's *Male Call*, were also in great demand.

Popular songs inspired another major category of nose art. Many designs were spinoffs from hits like "Pistol Packin' Mama," "Shoo Shoo Baby," "Ain't Misbehavin'," and "Sentimental Journey." Film titles and catchy lines made popular subjects, too, like *Classy Chassy*, taken from a clever comment by George Raft upon his first glimpse of Ann Sheridan in *They Drive by Night*. There were also portraits of wives and children and expressions of patriotism like the B-17s *Yankee Doodle*, *The Eagle's Wrath*, and *Old Glory*.

Last year Robert Bredau, a student at California State University in Sacramento, wrote his master's thesis on the anthropology of nose art. He analyzed about a thousand samples that he solicited from their owners through ads in aviation publications. He concluded that over 60 percent of the art

On a fighter like the P-51, the art could be as rakish as the aircraft itself.

Pop songs and pinups were common sources of inspiration for bomber nose art (below and lower right).

U.S. AIR FORCE MUSEUM



Nose artists were often enlisted men who were paid with cash or liquor—if they were paid at all (right).

NASM



displayed the female figure. Animal motifs furnished about 20 percent; the male figure, usually a cartoon character, about 10 percent. Another category focused on the pictorial symbol—flag, horseshoe, Liberty Bell, Uncle Sam—and accounted for about eight percent.

Bredau classed the graphics as folk art, not for stylistic reasons but because they served as what he terms “personal icons” for crew members. He says the art expressed a crew’s attitudes about everything from love to war, as well as a fervent hope to survive the battle. He also says that nose art was basically “a fun thing in a bad situation, an attempt to inject a little levity into the war.”

Once the war ended, thousands of the painted airplanes were sold to salvage dealers, who melted them down to make kitchenware for postwar America. Occasionally a few panels were saved from the furnaces when someone, usually an ex-airman, just couldn’t find it in his heart to destroy the art.

That’s how the Confederate Air Force Museum in Harlingen, Texas, acquired the nation’s largest collection of nose art. In the mid-1960s, Tully Pratt gave 33 panels, most of them from B-17s and B-24s, to the CAF. Pratt is the son of Minot Pratt, the manager of the metal salvage firm Aircraft Conversion Company, which owned more warplanes than the government after World War II. Minot

VALCO PHOTOGRAPHY, GARY M. VALANT



Pratt had supervised the scrapping of bombers at Walnut Ridge, Arkansas, but he felt that some memorable nose art should be saved. He ordered his staff to chop off certain panels of art before dismantling the aircraft. Years later, when Tully attended a CAF airshow, it dawned



PHILIP MAKANNA

Although best known for a shark-tooth grin, P-40s bore a number of imaginative motifs (above).

on him that the museum would provide an ideal home for the nose art that his father had rescued.

The U.S. Air Force Museum at Wright-Patterson Air Force Base in Dayton, Ohio, exhibits a few samples of nose art, including that on the B-29 *Bockscar*. The big bomber, which in 1945 dropped an atomic bomb on Nagasaki, sports a winged railroad car on its nose. The front of the walk-through replica of the Korean War B-29 *Command Decision* shows Dopey and Doc of the Seven Dwarfs in earnest consultation.

A problem arose when curators decided to add a couple of more typical examples. Officials worried that the nudity on the A-26 *Dream Girl* and the B-24 *Strawberry Bitch* might offend some visitors. Staffers made *Dream Girl*'s blouse opaque and painted a teddy on the *Strawberry Bitch*, but the museum still got occasional complaints about the B-24's name. Some tour guides now call it the *Strawberry Lady* in front of schoolchildren.

Arbiters of American taste have long perceived that nose art had a lot in common with vaudeville: it was colorful and entertaining but pretty lowbrow stuff. But art historians, sociologists, anthropologists, and pop culture mavens now study the surviving samples for clues to the values of a wartime

society in the throes of change. Some say the art served to bring America's ambivalence about sex into conscious focus—not bad for an art form with works bearing names like *The Wango Wango Bird*, *Wabbit Twansit*, and *Dippy Dave and his 8 Dippy Diddlers*.

This is all a bit much to the nose artists. Ted Simonaitis, who painted the exploding bomb on the B-26 *Flak Bait*, the nose section of which is in the National Air and Space Museum, does credit nose art with boosting morale. "It gave the plane an identity," he says, "and if a plane was getting famous, everyone wanted to get on it because it was lucky." But others shrug off any hint of social significance. "It was just a bunch of guys getting together and deciding what to put on their plane," says Dick Ayers. "It's like the horror stories I did in the '50s and all the psychologists were saying, 'Hey, there's something behind all this.' There never was. They were just stories."

Nonetheless, nose art specialist Gary Valant suggests that we ought to undertake a serious effort to document the art while we can. Says Valant, who gathered more than a thousand photos for his book *Vintage Aircraft Nose Art*, "The people who painted nose art won't be around forever, so the story must be written now. If we put it off another ten years, we may find that no one knows how and why nose art came to be." —



The Class of 1990

If you want to be an astronaut,
get ready for some stiff competition.

by William Triplett

When Duane Ross calls, people react.

"I broke out a bottle of champagne!" says Keith Taylor.

"I hopped around the room!" says Dick Stevens.

"I got home from a trip and found a note saying Duane Ross had called," says Bernard Harris. "I yelled at my wife, 'Duane Ross called and you didn't get ahold of me?!' She gives me this look and goes, 'Who's Duane Ross?'"

Who's Duane Ross?? Only the man who can change the course of your entire career! Only the manager of astronaut selection at NASA!

"I forgot to tell her!" Harris says. "I had to agonize until the next day to find out what he wanted."

What Ross wanted was to give Harris and the others the good news. From the nearly 2,500 applications NASA received from those hoping to join the astronaut corps, Ross and the selection board had painstakingly combed out the 106 lucky people they wanted to see in person. Taylor, Stevens, and Harris had made the cut. They were among *la crème de la crème*, all expertly qualified in diverse scientific or technical fields like metallurgy (Taylor) and space medicine (Harris) and military test-flying (Stevens). Overachievers all, with resumes as long as short stories.

"It's awesome," says Mike Coats, an astronaut himself and one of the 15 members of the selection board. "You look at their records—straight A's, Ph.D.'s, exam scores off the charts—and it gives us a complex sometimes. The most common comment astronauts on the board make is 'Gosh, I'm glad I'm not applying in this bunch.'"

This was the start of what NASA had recently announced as regular biennial astronaut hirings. NASA had 87 astronauts eligible for crew assignments, but

as Donald R. Puddy, director of flight crew operations, says, "The [shuttle] flight rates are increasing, and we have more astronauts in management positions now. We're looking at doubling the number of astronauts training for specific flights over the next year, and we're going to need to increase astronauts serving as flight-support too."

Sound like an open door? Get real. Out of the hundred fully qualified candidates a mere 20 or so might end up with jobs, and the board members have no problem leaving positions open if they don't like what they see. "I'm not going to fill a square just to fill a square," says Puddy.

For the final cut, the board planned to interview all 106 and give them the NASA physical, inviting them to come to Johnson Space Center in Houston for a week to be looked over—in effect, to go through NASA's version of *A Chorus Line*. So last September, Taylor, Stevens, Harris, and 17 other astronaut candidates reported to JSC, forming the first of five interview groups, each com-

Astronaut candidate Leroy Chiao was left up in the air after his August interview at Johnson; not until January would he learn if he had a shot at a seat on the shuttle.



posed of about 20 applicants equally diverse in training and experience.

One of them was Dorothy Zukor, 38, assistant executive officer to the NASA Administrator but a nuclear engineer by training. "I've been waiting to do this since I was seven years old," she says. "All they had to do was tell me where to write."

And write she did—you could wallpaper a hefty section of the space shuttle with paper from the five applications Zukor has submitted over the last 10 years. With each application weighing in at three pounds and standing about an inch tall, merely completing one is perhaps the first test of one's commitment. "I probably spent 30 hours doing mine," says Chris Seat, a test pilot from Edwards Air Force Base.

"It really is like finally getting your shot at Broadway," says Stevens, an Edwards test pilot who seems driven by a certain frat house energy. "Like getting that One Big Audition. I'm 36 years old. I've been dreaming about this for 25! John Glenn, Alan Shepard, these guys were my heroes!"

Despite the very grown-up world of postgraduate degrees these astronaut hopefuls now inhabit, the original childhood dream has never let go. To watch them talk about becoming astronauts is really to watch adult professionals talk with mounting self-consciousness about what they think would be the biggest gas they could ever imagine.

Over a breakfast of blueberry pancakes one morning, Dave Hollowell, 29, an astrophysicist about to begin work on nuclear weapons at the Los Alamos National Laboratory in New Mexico, says, "It goes back to the '60s when I was a kid and what was magical about space for me, and that was the science and exploring. We're living in a time where the past 30 years of research [on Earth]

is being transferred wholesale into space. I don't think any kind of scientist would deny that that transfer is a fascinating prospect."

"It's the perfect job," says Mark Shackelford, a nice thirty-something military test pilot hailing from Richmond, Virginia. "You work with great people, you do what you've been trained and educated to do, and it's what you've always dreamed of. How many people get to do what they've thought about since they were a kid?"

Not many—and most of those mak-

After Duane Ross' phone call, it was celebration time for Keith Taylor, wife Deena, and son Mark.

BOB KRIST



ing it even this close would get no further. Some tried to prep for it, but Ellen Ochoa, 31, knew better. Ochoa, a branch chief at NASA Ames Research Center who still looks a little like the girl next door, had been to JSC for an interview in the last batch of 100 in 1987. "You can't really do a lot of preparation, not even for the physical, because of the way the whole thing is structured," she explains.

Sunday, arrival day, began with an orientation session, complete with formal introductions to and welcoming speeches by the selection board. Then came the psychological/intelligence exam—for the rest of the afternoon and early evening. Some 1,000 true-false questions later the candidates gladly re-



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tired to their hotel rooms, but not before being asked to ready 1,500-word (or less) essays on why they wanted to be astronauts, to be submitted before their individual interviews.

Day two marked the start of the physical. "The vampire hit us with six test tubes Monday morning," Dick Stevens says. Blood tests were followed by echocardiograms, then muscular-skeletal exams, then eye exams—and then more exams! In fact, the overwhelming majority of the entire week was devoted to the physical. "They didn't just look at your retinas," Stevens says, "they took pictures of the insides." They didn't just give you a quick EKG; they strapped a heart monitor to your body for 24 hours. And they didn't just examine you with a normal proctoscope. You got—well, let Chris Seat, whose life as a test pilot depends on an ability to make judicious assessments reflexively, give you an idea of what that was like:

"I'd just as soon drive a nail through my head than go through that again."

He is not alone. Almost unanimously the candidates cited the proctosigmoidoscopy—complete with video camera inside—as the one singular sensation they'd rather not ever reprise, even though you *can* watch the whole thing on a monitor. Says Harris, "I told the doctor I was going to have to stop ordering these things for people now that I know what they're like. There's got to be a better way."

"This is the most intimate anyone will ever get with you," Mike Coats says. "This is the most thorough physical you'll ever get. It's one of the two main purposes we bring people here for."

Not that the board insists on perfect fitness. In fact, the results of all the medical tests reach the board as nothing more specific than "pass" or "fail." As Coats points out, "We don't care if you can run the marathon. We're strictly



checking to see if there's anything physically wrong with these people, because we want to be sure the people we select are in good enough shape that there won't be anything wrong with them a few years down the road."

Which brings us to the second—really the primary—"main purpose" the candidates are brought to JSC.

"It's not hard to make the first cut by paper," says *the* Duane Ross, a little guy with a friendly voice, "because a lot of people don't even meet basic requirements" (see "Prerequisites," p. 77). Checking references helps make the next cut, and the physical may eliminate another 10 or 20, but that still leaves at least 80 people qualified for a handful of jobs. "So what we're really evaluating in this whole process," Ross says with a

grin as big as Texas, "is the interview."

The interview. Sixty minutes that can start or end a dream. If becoming an astronaut is the turning point in a candidate's life, then the interview is the point on which everything turns, the hub within a hub, the hour you never forget. A week after his interview, Steve Hamel spoke candidly about his interview over lunch at the officers' club at the Patuxent Naval Air Test Center in Maryland, where he heads the Navy's electronic warfare and reconnaissance department. "Whatever I do from here on," he says quietly, arms at a dead rest on the table, "I'll know where I was when I reached that point. Ten, 15, 20 years from now, wherever I am, I'll know exactly where I was, the day I was there, the time, I'll know where I was

Bernard Harris had applied to the astronaut corps before but was willing to risk disappointment again.

sitting and who else was in the room. I will know exactly where I blew my turning point, if I blew it."

After you turn in your essay the board brings you in. "The set-up of the room is a little like a classic stress interview," says Mark Shackelford. "The table is T-shaped, and they put you in one of the corners so that there's always somebody behind you."

Dave Hollowell says his tensest moment of the week came two minutes before the interview. "But once you're in it, you become very calm," he says. "It's actually all very friendly."

The first astronauts were test pilots. Chris Seat, Dick Stevens, and Mark Shackelford (left to right), all of whom fly at Edwards AFB, hope to continue the tradition.

CAROLINE SHEEN

"They ask about you, your family, your work a little, and even sometimes about current events," says Leroy Chiao, 29, an affable materials engineer from the Lawrence Livermore labora-

tory near Berkeley, California. "It's really 'non-structured.' Most of the questions really have nothing to do with space or your application at all."

The informal atmosphere can calm



you or unnerve you. "Man, I have been second-guessing my answers since I came out of it," says Stevens. "I've been *dreaming* second-guessing." Ditto for another candidate who, like



Ochoa, had been through this once before: "I can feel it just like last time. I'm going to be spending the next two weeks thinking again, *I should have said this or I shouldn't have said that*, and then, *Oh, God, they're going to think I'm a real dildo!*"

It's been said that the biggest mystery in NASA is how they pick astronauts, and here's a clue why. "You try to come up with a scale for these things," says Coats, "but how do you assign numbers for character?"

The times have changed since those somewhat legendary days of "the Right Stuff" and astronaut derring-do. Today everyone seems to believe that the *sine qua non* for being an astronaut is the ability to be a team player. And they are right. "You need someone who can take orders," as Coats says, though you don't want someone who sits around and waits for them.

Technical skill is also important, as is a certain enthusiasm for working in areas outside your discipline, since the reality of astronautics is that you spend far more time in various managerial and support positions—working with contractors, maintaining ground communications at Johnson—than you ever do flying through space. "That's one of the big points we try to make," says Puddy. "It's one of the most common misperceptions. If someone applies here and their only intention is to be assigned a spaceflight, we can't afford 'em. That's why we advise them to talk to the astronauts while they're here—find out what it's really like."

The ability to adapt—to different and sometimes challenging environments,

NASA



like space—is also highly prized. But the most important quality, the ultimate NASA yardstick, goes under the ominous rubric of "Other."

"It's anything that gives you a sense of who they are as a person," says Ross. No small concern, that. "Astronauts are the most visible of the NASA population. When they say something publicly it's not like 'Joe Astronaut says...' It's perceived as 'NASA says...' So you've got to be sure that whatever 'NASA says' is what NASA really wants to say." Add the fact that astronauts must work together often in tight spaces for long periods of time, and it's clear why personalities as well as skills must be compatible.

And how do they gauge that? "That's why we ask them a whole lot of different questions in the interview: to see how they handle themselves, see how they handle pressure, find out who they are," says Ross. "Doesn't matter what you ask. It's how they answer is the important thing."

"You can measure education and experience," says Puddy, "but obviously there's got to be a certain amount of subjectivity involved."

Prerequisites

Applicants for the astronaut corps must meet the following minimum requirements before submitting an application:

Both mission specialists and pilots must be U.S. citizens and have a bachelor's degree from an accredited institution in engineering, biological science, physical science, or mathematics. An advanced degree is preferred. Mission specialist candidates must also have three years of related professional experience; a postgraduate

degree may be substituted for part or all of that requirement. Pilots need at least 1,000 hours of pilot-in-command experience in jet aircraft, and preferably some flight test experience.

Mission specialist candidates must have uncorrected vision of 20/100 or better and blood pressure of no more than 140/90 in a sitting position; they must also be between five feet and six foot four. Pilot candidates must have vision that is 20/50 or better uncorrected, correctable to 20/20 in each eye. A pilot must be between five foot four and six foot four.

Indeed. According to Ross, that inef-
fable "Other" counts for "more than
half," so whether a candidate's star
rises or falls is less a function of qualita-
tive elements than of simple gut feel-
ings. Of course, NASA's needs will also
play a role. The agency may be looking
for more, say, mission specialists than
pilots (as is currently true), but there
will be more perfectly qualified people
than there are jobs (also currently true).
So despite all the advanced degrees, the
thousands of hours of high-performance
flying or micro-processing, the enor-
mous wealth of scientific expertise, this

*Ellen Ochoa interviewed at Johnson in
1987. Afterwards, "it was hard not to
think about it," she says.*

CHRISTOPHER SPRINGMANN

final stage of the selection process,
meticulously structured as it is, ulti-
mately turns out to be as objective as
really brainy potential roommates feel-
ing each other out.

"Exactly so," says Puddy. "We want
to know: Can we live with you, and can
you live with us?"

Naturally the board would love more
than 60 minutes to get those crucial an-
swers. So would some of the candidates.
"I would challenge the board to prove
that after one hour they really know
who I am," says one. But logistics don't
allow more time. As Coats concedes,
"One of the ground rules of this process
is you are going to miss some of the
very best. It's frustrating because from
time to time you let somebody go you
wish you hadn't. But you can't work it

that way. So you just try to hire some-
body you're not going to feel sorry
about down the road."

"They can pick who they want,"
Chris Seat summed up with poignant
fatalism, "and not have to justify it to
anybody."

Even if not picked, all candidates say
they will have enjoyed the JSC experi-
ence itself. Meeting real live astronauts
was a genuine high for everyone, espe-
cially Dave Hollowell, who got to drink
beer with several of the Chosen and lis-
ten to them talk about where they like
to ride their dirt bikes. Nary a discour-
aging word was heard from any candi-
date about the process. Says Ross,
"They all seem to have a good time
while they're here, except for"—that
Texas grin comes back—"the procto."





CAROLYN RUSSO

Future astronauts may return to the moon or travel to Mars; Steve Hamel would like to be among them.

There would be at least four months of waiting until the board could see and decide on all five interview groups. "I am not going to think about whether I will be selected until they call to tell me—which is a *lie*," says Stevens. "I will *try* not to think about it." Most candidates, like Keith Taylor, planned to protect themselves from total letdown by accentuating the positive. "I'm happy with the job I have now," Taylor says steadily, as if trying to test the ground beneath him. "I'm not anticipating I'll get hired or hanging my career on it. The way I view it is: This is a dream I'm pursuing and will continue to pursue so long as there's a chance."

The ones who've been turned down once already may have the toughest time. "To have gotten so close..." says Bernard Harris, who applied back in 1987. "It was certainly disappointing. Even when they encourage you to reapply, you get depressed, you go through a grieving period, you analyze what might have gone wrong, and you do start to think that maybe you didn't have the Right Stuff."

So how can it be worth it then? How, when you know the competition is fierce, when you know that your Childhood Dream is at stake, when having it denied is going to hit you like a freight train, and you know that even if you *are* selected you could spend five or more years in trench work before ever getting *near* a flight assignment... *how is it worth it?*

"I sort of asked Joe Engle that ques-

tion," Mark Shackelford says, delicately recalling his conversation with the astronaut. "He looked at me and he said, 'It's really amazing to go up and sit in space, and you look down on this big blue ball and you realize that everybody you know, and everything you've ever seen and experienced, and everything that's ever existed—all of it is on this blue ball that looks like [something] you could hold with your two hands. It's truly awesome.' And then he got kind of teary-eyed and said, 'You bet it's worth it.' I'll take that kind of recommendation any day."

Last January, NASA released the names of its choices. Bernard Harris, Ellen Ochoa, and Leroy Chiao were among the 23 people selected. They will report to Johnson Space Center in July to begin training. —

NASA



The Battle Over Warbirds

You could call it a war over attrition.

by Stephan Wilkinson

In the 1940s and '50s, World War II veteran aircraft of every sort were scrapped by the airfieldful and nobody gave a hoot. Nobody except a bunch of guys from Texas who saved a few from the smelter and put together the Confederate Air Force. Those airplanes, which back then went for the price of used Buicks, are today worth more than Donald Trump's

CONFEDERATE AIR FORCE



The CAF Ghost Squadron now has a true ghost. The last flying example of the Douglas A-20 Havoc crashed two years ago in Harlingen, Texas.

petty cash account, and that's in large part because the CAF Ghost Squadron started flying the old crocks, eventually entertaining thousands with their own annual exhibition as well as their performance at the Experimental Aircraft Association's Oshkosh airshow. Soon warbird air forces were being commissioned in enough regions to replay any number of wars.

In the meantime, several unfortunate things have happened. A number of those airplanes have been destroyed in crashes. Some of them are being misrepresented as birds they never were. And a few that were once truly historic are suffering from Washington's hatchet syndrome: The head's new and the handle's been replaced a couple of times, but other than that, it's the very hatchet he used to cut down the cherry tree.

Say the warbird owners, "So what? If it hadn't been for the thousands of dollars and hours we spent on restoring them in the first place, they'd all be cut up for razor blades."

Say the warbird preservationists, "There's a responsibility, a stewardship that comes with owning something of historical importance. You don't put aluminum siding on a Frank Lloyd Wright house, and you don't use a Hi-Liter on the Gettysburg Address. We're not saying don't fly them—unless it's absolutely the last surviving example of its type. We're saying fly them gently, carefully, occasionally, safely."

Obviously, flying older combat aircraft has caused some human casualties, which people on both sides regret. But the preservationists want us to consider another tragedy: the widespread destruction of artifacts. Over 200 World War II combat aircraft have been destroyed in crashes in the United States alone since 1964, which is roughly when the warbird-restoring hobby picked up steam, and the count doesn't include transports, Stearman crop dusters, or 1950s trainer types. The 200 lost airplanes are P-51s, B-17s, Corsairs, Messerschmitts, and the like.

Worse, some of them have been extremely rare—most recently the last flying Douglas A-20 Havoc, which crashed two summers ago during a CAF airshow in Texas. (The pilot had suffered a massive heart attack, but nobody can say whether it happened before or after one fuel tank ran dry.) And not long ago, the sole remaining Bristol Blenheim cartwheeled across an airfield in England only a few flying hours after having been restored from rubbish. The owners say they'll rebuild it again. Their devotion is commendable, but what they'll end up with is more Washington's hatchet than Bristol's Blenheim.

"I feel badly that we're losing so many of them," says Charles Collins, a former Air Force experimental test pilot, longtime chief pilot for MIT, and an active warbird check pilot and safety advisor. "One of the things I find most depressing is that the people with the financial wherewithal to buy these things are often inexperienced. They're not military-trained pilots with that frontal lobotomy that tells them what to do next in an emergency."

Serving as a safety director at a recent New England airshow, Collins noticed one warbird pilot taxiing out to fly his aerobatic routine for the crowd in a P-40 with not one but two heads in the cockpit: the pilot had put his wife in the fighter's single seat and was sitting on her lap. "We stopped him," Collins says. "He didn't like it, but he went out and did the show



FRANK B. MORMILLO

Having gained its reputation in the Pacific theater, the Corsair today plays for crowds at the Planes of Fame air show.

solo. When the show was over, his wife hopped in, he sat on her lap, and off they went.”

Sixty-six-year-old William Ross has owned 24 serious warbirds, including four P-51 Mustangs, a particularly rare P-38 Lightning, and the world’s last Grumman F3F biplane fighter, subsequently destroyed by an in-flight fire. He no longer flies fighters, but he admits, “I’m one of the guys who started doing this way back in the ’50s, and I feel they should be flown and displayed to as many people as possible.

“Go to the Smithsonian and they have an airplane that I flew when I was still in college, in 1947, and it doesn’t mean a damn thing. It’s just an old P-40 hanging there. You can’t hear it, can’t see it work. I don’t know how many people they run through the museum a year, but in one day at the Oshkosh airshow you have 400,000 people seeing these airplanes flying.”

In 1989 that figure was 850,000. But it took the National Air and Space Museum only three

weeks last summer to show their P-40 to that many people. Of course, the visitors filed past the P-40; the P-40 did not roar past the visitors. The museum’s position is that its artifacts are in the national trust and must be protected for future audiences.

We can concede that flying warbirds has an educational value, but let’s acknowledge that this isn’t the only reason pilots want to keep them in the air. “A certain airplane might be the only one left—and this is probably a selfish point of view—but I think I’d have a hard time resisting flying it,” says retired RAF Air Vice Marshal Ron Dick, the International Fellow at the National Air and Space Museum. “There’s a natural arrogance every pilot has—‘I’m not going to break it,’ you say to yourself. And if I didn’t feel that way, I wouldn’t deserve my license.” Dick was on the board of directors of the International Group for Historic Aircraft Recovery until September 1987. When TIGHAR publicly criticized flying one-of-a-kind aircraft, he resigned.



FRANK B. MORMILLO

Crunched on landing at a Reno Air Race, this P-51 Mustang has since been restored and is flying again.

"There are certain aircraft I wouldn't think of flying," Dick admits. "One of the most stunning aircraft ever built was the Macchi-Castoldi MC.72 Schneider Cup racer, and there is only one left. It was an amazingly dangerous creature. Bloody dangerous. If someone were to wheel that out and say, 'Let's fly it,' I think the risk is far too high. On the other hand, you take a C-47, there's one in the U.K. that took part in the parachute drop on Arnhem. That's a truly historic aircraft, but I don't feel a bit bad about flying it. Because it's a pussycat, not because there are lots of C-47s left. There are, but very few surviving from Arnhem."

The small group of owners who often pay half a million dollars to make an old fighter flyable refuses to be told that now it can't play with its expensive toys. Though the concerned people at TIGHAR published an endangered species list, their proposal to protect the aircraft on it does not, despite the group's acronym, have teeth.

"There is nothing equivalent to the laws that control historic buildings in the area of historic objects, vehicles, or aircraft," says Randy Mason, curator of transportation artifacts at the Henry Ford Museum, in Dearborn, Michigan. "And I think to make such laws would be problematic, as it would impact issues such as civil rights. The only thing you can do is appeal to a private collector's intelligence and logic."

TIGHAR says things could change. "The government *can* tell you what to do with private property, as anybody who has ever dealt with a zoning board knows," points out TIGHAR president Patricia Thrasher. "If the federal government ever gets into the act, you

will not fly historic aircraft. These are not little old ladies in tennis sneakers. The Advisory Council on Historic Preservation includes some of the most powerful lawyers in the country. They tend to win."

"It's our position that would not be a good thing," TIGHAR's Richard Gillespie adds. "We don't want to see the government step in and tell us what to do."

Mason in truth has little argument with warplane collectors flying their toys, for he feels their thoroughly renovated machines are no longer historically significant. "In terms of what museums do," Mason explains, "which is preserving material culture, sometimes with aircraft there isn't much to preserve. Some have been so obliterated by remodeling and restoration that there isn't anything original left. Restoration, after all, isn't anything more than a series of replications."

The Science Museum in London displays a Spitfire and a Hurricane that still bear the oil, cordite, and dust of the day they were taken off the flight line. They haven't been touched since, and they are vastly more legitimate artifacts than all the world's chromed and re-engined, Imroned and Ioraned "restorations." You'll never hear their Merlins make the sound of ripping gingham—the inevitable rationalization of the "ya gotta hear 'em fly" crowd—but it doesn't matter. They were there, part of history.

Other Spitfires no longer are. One crashed last summer, killing its pilot owner. "But that Spit was a 'bitsa,'" explains Ron Dick. "They took bits of this and bits of that and made up a Spitfire."

And some Spitfires never were. "They're building Spits right now," says William Ross,

who in the 1960s owned the only flying Supermarine Spitfire in the Western hemisphere. "They just get a serial number and one little part off an original, and there are guys in England building wings, blowing canopies, and making most of the other stuff. Who the hell cares if it's an original or a replica?"

Easily the most respected and admired living-history museum in the United States—perhaps in the world—is the painstakingly restored colonial village at Williamsburg, Virginia. The president of Colonial Williamsburg, Charles Longworth, happens to be an active and experienced pilot. How does a man who loves airplanes well yet honors history more feel about the flying of valuable warbirds? "I like to see something in use," says Longworth. "I fight with our curators all the time, because they'd like to put things in isolation, under glass, in dehumidified and hermetically sealed environments. The fact is, the objects in Williamsburg were in a context when they were used, and when they aren't, they lose their life. There's nothing sadder than seeing an F-86 sitting on a pedestal in front of some Air Guard unit at an airport. I'd rather not see it that way.

"If you have the last P-51 in the world, I would argue that it should be put in the Air and Space Museum. But if you have more than one, I don't see any utility of them sitting around in the dark. To see a B-17 thunder by is worth a helluva lot more to the people who get to see it than having one sit on the ground for the next thousand years."

There are good reasons why we should leave warbird owners to do what they want with their airplanes. Certainly they serve an educational purpose, just as Williamsburg or Fort Ticonderoga or a Gettysburg reenactment does. Certainly they are accessible to the widest possible audience. Certainly it is an enormous bargain when for the price of an airshow ticket a single spectator is provided with perhaps \$60 million worth of entertainment, as was the case when nearly 300 warbirds convened at Oshkosh for the airshow last summer.

But it is also important to point out that the warbird movement has turned what might once have been true artifacts into a flying theme park—less a Williamsburg than a Frontier Town. Putting a second seat in a fighter certainly makes it more fun to fly, just as electrifying a Stradivarius would make it a louder fiddle and cutting up a Chippendale to make space for a word processor would make it a more useful desk. But that kind of change

would also end their value as originals.

The debate appears to rest on a definition of terms. What is a historic aircraft? If there's a warbird loose that took part in the Arnhem drop or the Marianas turkey shoot, that battered Ploesti or actually went gunning for German locomotives during the glory days of 1944, it can be found, declared a national treasure, and treated accordingly. For the airplanes that have had their guts torn out to make room for passenger seats or avionics or the modern systems necessary to make them reliable enough to fly, it's really too late.

In the end, the savior of important, historic, original warbirds will probably be our limited attention span. "We're talking about people who are 60 and above, who still have a love affair with a World War II fighter and want to invest the dollars to preserve it in flying condition," John Ellis points out. Ellis is a director as well as the safety officer of Warbirds of America, a division of the Experimental Aircraft Association devoted to preserving combat aircraft and keeping them flying. "We are not experiencing a lot of young

The B-29 and B-17s of the CAF bomber wing survived World War II and, so far, the airshow circuit.

CONFEDERATE AIR FORCE



people getting involved with these airplanes," he says.

"I sit around the Warbirds of America directors table, and the only person who doesn't have gray hair is the guy from the Combat Jets Museum in Houston. At Oshkosh, you used to see a simulated shootdown of a Zero by a Wildcat, but we didn't do it this year. Most people instead wanted to see the simulated shootdown of a MiG-15 by an F-86. I fear the restoration of World War II piston-powered aircraft will be doomed by a lack of interest." ➔

Countdown

When American Airlines decided to inaugurate 747 service ahead of schedule, the company cut itself a short fuse.

by John Flanagan

The night of Tuesday, February 24, 1970, was bitter cold in Tulsa, Oklahoma, and a steady wind blew across the ramp at American Airlines' maintenance base. Around midnight a crowd outside Hangar 5 strained to see a 747 on approach. The airplane was arriving straight from the Boeing factory near Seattle, Washington, where hours earlier it had been turned over to American. Finally, the 747's distinctive outline could be discerned, and shortly after, the airplane touched down and taxied to the ramp. As the giant hangar doors rumbled open, the four enormous Pratt & Whitney JT9D fanjet engines shut down and a tractor pulled the 747 inside. The doors closed behind it, and crews rolled power carts and stands into position for the squads of technicians poised to swarm over the airplane.

The small army of American employees surveyed the giant airliner with a mixture of pride and fear. Their pride was understandable, and their fear could be traced to two sources: this was the first jumbo jet they'd ever beheld—and they had six days to get it ready for commercial service.

In the mid-1960s, when Boeing began taking orders for the first wide-body jet airliner, American had been unsure of the economic viability of flying such a large aircraft on its domestic routes. Pan Am was the first to order the 747, and before American finally ordered an airplane for delivery in June 1970, two of its biggest competitors, United and TWA, had already secured earlier slots in Boeing's order book. Now American felt threatened. It would have to play catch-up. The airline's executives met and agreed that if American wanted to meet its competition, it had to get a 747 earlier than June. Figuring that Pan Am might find itself with more 747s on hand than it needed during the slow winter months, the executives decided to approach Pan Am and ask about leasing one of its wide-bodies.

American Airlines ordered its 747s in time for the Boeing rollout ceremony on September 30, 1968 (its logo is in the top row, near the nose), but rivals had earlier delivery dates.



BOEING





Pan Am agreed, and American decided to accelerate its entire program. Pan Am would turn over its eighth 747, set for delivery on February 22. The inaugural flight of American's first "Astroliner" would be made from Los Angeles to New York on the morning of Monday, March 2, with a return flight that afternoon. As manager for operations planning, I'd been told I'd oversee the effort to introduce the 747 when it entered service in June, but the company had just lopped three months off our start date.

We needed new equipment and facilities to handle an airplane that stood some four stories high. All baggage would be loaded into new containers called LD-3s instead of being stowed piece by piece. The new food carts and catering equipment were larger and heavier than anything we'd ever seen. Even the towing tractors were overmatched by a 350-ton airplane. The name "Astroliner" was proving to be appropriate—the 747 would be as much

like an ocean liner as an airplane.

About a week before the airplane was delivered to Tulsa, American held a meeting at Amon Carter Airport, near Fort Worth. Cockpit crews and executives sat down with ramp service, passenger service, and maintenance staffs to have a look at the program schedule. Some pilots wanted to know why Palmdale, north of Los Angeles and well out in the boonies, had been selected instead of California's Ontario as the alternate airport to use in the event of weather problems at Los Angeles International. When an engineer explained that Ontario's runway couldn't handle the weight of a 747, one pilot said, "I'll go to Phoenix before I land all the way out in the desert at Palmdale."

"That's fine, Captain," replied the ramp manager from Phoenix, "except we'll have to deplane the passengers using a maintenance stand, and it'll take about two hours to unload the bags using a forklift."

"That's not the image we want," someone from passenger service piped up. "Just the thought of a forklift near

my airplane gives me the willies," added a representative from maintenance. The ramp manager for Los Angeles assured the flight crews that charter buses had already been contracted to be on call if a flight was diverted to Palmdale. Then Ted Melden, vice president and head of the flight department, took the floor. Melden was a seasoned pilot, and he had everyone's attention.

"This is a new concept of flying," he began. "You have to plan more carefully, anticipate your next move. If you have a precautionary engine shutdown mid-continent, you go into the maintenance depot at Tulsa, not Chicago or St. Louis. We don't happen to have spare multi-million-dollar engines lying around . . . We'll cover the details next." Someone dimmed the lights, and a slide appeared on a screen with an entire schedule of tasks that had to be accomplished before the Federal Aviation Administration would issue American an operating certificate for the 747. A full-time inspector had been assigned to American, and he watched everything we did.

One requirement called for a series of proving flights to the cities the airline would serve, plus one to an alternate

Magnum Opus

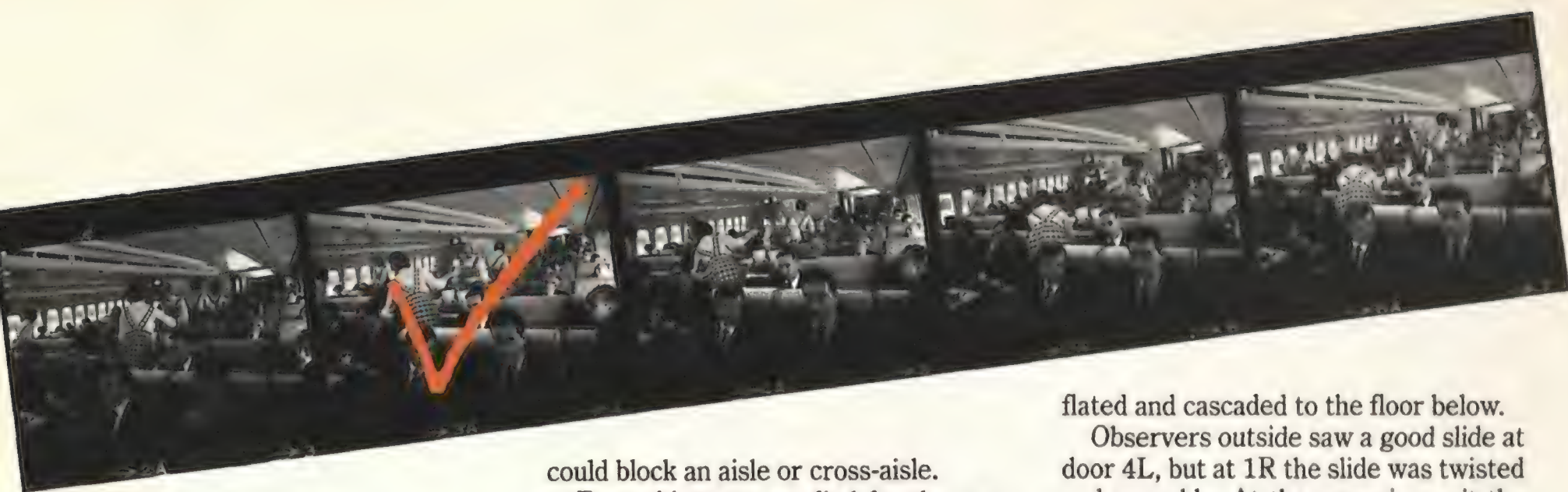


The 747 was large by design, but since the day in April 1966 when Boeing announced its intention to build a 490-seat behemoth, the airplane has become a sort of growth industry unto itself. The original plans called for the 747 to weigh 710,000 pounds on takeoff, but by 1968 that figure had already grown to 775,000 pounds, and in 1988,

Boeing's latest version, the 747-400, took off from Moses Lake, Washington, weighing in at a whopping 892,450 pounds.

The startling increases in weight were made possible by a succession of engines with equally startling thrust ratings, beginning with the original Pratt & Whitney JT9D, rated at 41,000

pounds. But that didn't last long: the JT9D-3 immediately upped the figure to 43,500 pounds. Today's 747-400 can be equipped with General Electric, Rolls-Royce, or Pratt & Whitney turbofans. The PW4000 engines on that Moses Lake flight were rated at 62,000 pounds of thrust—nearly half again as much as the original JT9D's rating.



airport. Before and after each leg, all required maintenance and service checks would have to be performed up to FAA standards and under the scrutiny of the inspectors. A critical failure could jeopardize the start of service.

But even before we could run the proving flights, an emergency evacuation demonstration had to be run successfully. More than 400 passengers had to exit the airplane in 90 seconds or less using only five of the 11 exits and inflatable escape slides. The test had to be conducted in the dark to simulate worst-case conditions. Then came unexpected news: Boeing slipped the delivery date two days. The team at Tulsa met to revise the schedule and tighten everything up. There would be no slack anywhere.

In the maintenance hangar at Tulsa a couple of hours after the airplane had been received, seats were hoisted aboard and another 50 rows moved to set up the cabin the way American might operate it on a maximum-capacity charter flight. Some of the temporary seats were nothing more than boards with seat belts. The 400 volunteer "passengers" had been alerted to be ready for the evacuation test, now scheduled for early nightfall Wednesday.

Evacuating a loaded 747 required a totally new concept in decision-making. In smaller airliners, a signal from the cockpit crew initiated the evacuation. But the cockpit crew of a 747 was up on a second deck, isolated from the cabin. Now the cabin crew would be making the critical decisions. And there would be contingencies to consider: a collapsed nose gear would raise the tail, so evacuation through a rear door could cause a fatal injury; spilled or burning jet fuel would probably not be visible from the cockpit; galley or lavatory fires

could block an aisle or cross-aisle.

Everything was readied for the test. The volunteers were assembled, each having been offered \$10 and a gift for his or her participation. The atmosphere was festive even though the space heaters couldn't cut the chill in the big hangar. The cockpit crew filed aboard, followed by 10 stewardesses—the minimum complement—and the 400 volunteers. A wooden stairway had been specially built for the occasion. George Reynolds, an interior design engineer, recalls that the stairway was enclosed in black muslin: "We didn't want the people to know how high up they really were." The door closed and the stairway was pulled away. FAA inspectors took up their positions. Only they knew which five slides would be deployed.

Company employees stood around the hangar watching the rotating beacon atop the massive fuselage. At the FAA's command, electrical power would be cut, the beacon would go dark, and the evacuation would begin. As the crew commenced emergency briefings, the party atmosphere on board gave way to a more serious mood. The stewardesses pointed out the exits and designated passengers to assist them. The cabin fell silent. (Stewardess Bunny Burgess remembers the adrenaline rush. "Our total focus was to get the doors open, to get them out," she recalls.) Then the rotating beacon went out.

On board, the emergency lighting came on. "EASY VICTOR! EASY VICTOR!" the PA speakers barked. The cabin crew flung off their harnesses and dashed to their assigned doors, peering through the windows; some saw a red glow—a simulated fire. Those exits were unusable, and the doors had to be blocked. Where the path was clear, the crew members rotated the emergency handles to activate the power-assisted double-width doors. Rubber slides in-

flated and cascaded to the floor below.

Observers outside saw a good slide at door 4L, but at 1R the slide was twisted and unusable. At the overwing exit the slide inflated, then snaked under a wing, and several safety observers had to wrestle it into a better position. After some passengers had used another slide, it began to go limp—no good. Then another good one deployed. To those outside the airplane, it was already apparent the test had failed.

But the cabin crew didn't know that, and the evacuation continued. Stewardess Janet Luft recalls, "It was a real-life situation, just like a real emergency. People were screaming, helping each other. We were shoving people out the door." The stewardesses reacted coolly, redirecting people to the three good slides and blocking the bad ones. It took just under two minutes to get everyone out, and there were injuries: twisted ankles and, tragically, one broken back. The test would have to be run again, and now the inaugural flight was in serious jeopardy. Luft felt "like we personally failed. All the people were counting on us. It was devastating."

American regrouped. Some wanted to repack the slides and try again right away, but wiser heads called for an engineering review before another attempt. The FAA insisted on a completely new set of volunteers and a new crew. Replacement slides and inflation bottles were on hand, and we had a spare crew, but a whole new group of volunteers was another matter. The second test was scheduled for later that evening with 400 relatives of employees hastily recruited as replacements. This time when the beacon went dark, all five slides deployed and everyone made it out in less than 90 seconds. At 8 a.m. on Thursday, February 26, the airplane lifted off for Los Angeles. We were down to four days.

With Captain Walt Gosnell in the left seat and FAA inspector Joe Bell in



207



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A70-747

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A70-747

210



A70-747

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205



209



the right, N740PA eased into gate 44 at Los Angeles. The turnaround sequence, involving upwards of 50 separate units, including baggage tugs and carts, service trucks and stands, and fuel equipment, had been completely choreographed so that no one set of equipment blocked another group's access. Scale models of both Los Angeles and Kennedy terminals had been built, complete with miniature ground equipment, which could be moved around to simulate various servicing sequences. But now it was time to do it for real.

Problems surfaced immediately. Baggage trains couldn't make tight corners, so they were shortened, which required more tugs. Cabin and galley service trucks had trouble positioning, so marks were painted on the ramp. As the aircraft was loaded it settled on its wheel struts, and sensors were adjusted so the loading equipment would settle with the aircraft. Then there was a mixup in security, and American employees working on the proving run found themselves barred from the airplane. Their ID badges were finally honored after a heated exchange.

During a routine inspection, mechanics discovered a malfunctioning leading edge flap: one link had broken and another had bent. Bill Cowley, the maintenance superintendent in charge, was on top of it, but he was being pressed on all sides to forecast a firm time when the flap would be fixed. "Parts plus two hours," he finally announced. But his tormentors wanted "hard numbers." A Boeing representative called Seattle and located a part. Maintenance figured out a way to save the time that would have been needed to transport the flap to a shop. Joe Bourgouin, a maintenance foreman, recalls, "We laid the broken flap section on carpeting under the wing, and a temporary jig was fabricated, awaiting the part. We also rigged some temporary lights because it was getting dark." They began refueling and stocking the airplane while the flight crews arrived and began preflight inspections. Ground handling crews

Only one gate was ready at Los Angeles International, but there was room enough to practice ramp operations.

boarded a 707 to JFK so they'd be in place to receive the same airplane they'd just finished training on. The repaired flap was cycled back and forth—it checked out okay. At 9:30 p.m. Thursday night, the Astroliner pushed back on schedule. It was now three days, 10 hours to the start of scheduled service.

We touched down at Kennedy at 6:23 a.m. on a cold, dreary Friday morning. Now it was the Kennedy staff's turn to get the first crack at a real airplane. To Norm Rice, area manager for aircraft maintenance, the startup operation was "burned in my memory.... People worked 20 hours a day for two and three weeks. It was like a guillotine ready to fall." Rice's biggest problem was simple enough: no push-back tractor. American's first one had gone to Los Angeles; Pan Am had none to spare. He finally found one at Air France, and that airline's schedule dovetailed with American's. But the French-built tractor was complex, and it frequently broke down. Most of the Air France mechanics spoke English, but when the problem was serious, they sent a tech rep, who spoke only French. Fortunately, as maintenance foreman Herman Zucker recalls, "an [American Airlines] avionics mechanic, Christian Rampin, spoke fluent French. He would work with the tech rep. Or we would send him out there to curse at the tractor in French. That sometimes helped. At least it made us feel better." To keep his options open, Rice modified the old Hough tractor used to move the 707s by adding some concrete weights for extra traction.

The next leg departed Kennedy in mid-afternoon, on schedule for Los Angeles, and the five-hour turnaround at L.A. was uneventful. We now aimed for a late Friday night departure for Dulles airport. As the passengers gathered at Los Angeles, the load totaled up surprisingly heavier than projected—something was wrong. Planners reviewed the check-in lists and realized that a courtesy invitation to the local FAA office to observe proving runs had been accepted in spades. The aircraft was already scheduled to be double-catered (there was no 747 catering service at Dulles), and now extra meals had to be ordered on short notice.

Sleep was becoming impossible for those of us in the team charged with

AMERICAN AIRLINES



The author (left) and Larry L. Strain coordinated American's preparations for its first jumbo flight.

managing the proving runs. During the Dulles leg, the multiplex system that controlled the movie, the audio, the cabin lights, and the stewardess call buttons began to run amok. The drama of a gunfight scene in the movie was heightened by blinking overhead lights in the aft cabins. Then, on landing at Dulles, some dishes let loose with a crash. The FAA pens wrote furiously. A baggage hoist malfunctioned, and an unapproved access stand was used to reach the refueling panel on the wing. Things were unraveling.

With all outsiders barred, the team met quietly in a room at Dulles. Back to basics. Attention to detail. Success was too close to lose it now. The aircraft was performing admirably; people were making the mistakes.

The flight from Dulles to Los Angeles went much more smoothly. Four down, two to go. Spirits picked up in the balmy California weather, but now another flap failure loomed. Maintenance was unable to get a green indicator light for the leading edge flaps, and the problem was isolated to a section near the number two engine. There was a scheduled 12-hour layover—plenty of time to fix the errant flaps—and the proving run team was looking forward to a shower and sleep. But it was not to be.

Shortly after landing, I took a phone call from the dispatch center in Dallas. It was early Saturday afternoon, and the caller was Ted Melden. "I've been watching the weather forecast," he



N740PA is back with Pan Am now, and last February 14 it set an LAX-JFK speed record.

said. "I don't like the Los Angeles picture." He was right. The forecaster had just given me an update, and it called for fog by eight that night. "John, I want that airplane out of there," Melden said.

Joe Bourgouin and Bill Fey, the maintenance foremen, had the flap problem localized to a sensor inside the wing—the actuator was working perfectly but somewhere a contact on a sensor switch wasn't closing. They hit on the solution: put someone inside the wing, retract the flaps, and hope he could see the malfunction. Davey Lee, a mechanic, was chosen to wriggle into the cavity behind the extended flap. When they retracted the flaps, Lee spotted the problem, but when the flaps were set to extend, they wouldn't move. Now Lee was trapped inside. The team heard muffled cries and the sound of Lee's fist banging against the wing. They used backup

electrical power to extend the flap, and everyone still remembers the expression on Lee's face when they finally pulled him out.

In the revised schedule, the airplane would stay on the ground at JFK for almost 20 hours before it returned to Los Angeles on Sunday. I called my boss, George Warde, senior vice president for operations, at his apartment in New York; it was early Saturday evening his time.

"George, we almost have it, but I need your help," I said. I filled him in on the flap, the fog, and the early departure. "The airplane is going to end up on the ground at JFK for almost 20 hours," I explained. "If we get back on the original schedule, we arrive at LAX [Los Angeles] at 12:30 in the morning, with barely eight hours before the inaugural flight. If we have another flap problem, we might just blow the whole thing."

Warde asked why we had to stay at Kennedy, and I described to him a curious tax law phenomenon: on the first of March, California assessed property

taxes. Almost every piece of property that would move—planes, trucks, you name it—rolled or flew out of the state for the day. American's tax department wanted the 747 out of California until March 2. Warde got the picture. "Let me make some calls," he said. "I should have the answer when you get to New York. Good luck."

The 747 lifted off for Kennedy as the first traces of fog were creeping toward the coastline. The mood on board was jubilant; success was within reach. Some five hours later, the Astroliner touched down with Captain Walt Gosnell at the controls. Joe Bell, the FAA check pilot who'd borne the brunt of the proving flights, said to Gosnell, "Good flight. I don't want to see you for at least six months or a year." Gosnell had completed his line check—another hurdle passed. The gate at JFK still wasn't finished, and we deplaned down some mobile stairs. Everyone headed for hotels and some sleep. Our departure time was indefinite.

Wake-up calls started coming

through at mid-morning on Sunday: meet at noon, they said. We would be departing early in the afternoon for an evening arrival in Los Angeles, and now we'd have 15 hours of ground time there to ready the aircraft for its first paying passengers. Warde had made the right phone call; a California tax bill was a small price to pay for ensuring that the first flight went well. Rice's planning paid off when the French tractor broke down and he had to use the old Hough with the improvised ballast to push back from the gate.

Even the multiplex system behaved on the final proving run to Los Angeles. We had the sense that everything was now coming together. In five days we'd pulled off two evacuation tests, a string of closely scheduled transcontinental flights, training, and maintenance—both planned and unplanned—all with a few hours to spare. That day, the FAA signed our operating certificate.

At Los Angeles they began grooming N740PA for its public debut. Everyone working aboard removed their shoes, and by the time they were done, the airplane was spotless—even the 361 ashtrays had been scrubbed. The ticket agents arrived early, trousers creased

and blouses crisp. Cockpit and cabin crews held briefings before boarding. Passengers began checking in, and the flight began to fill—we'd have 371 people on board, including crew.

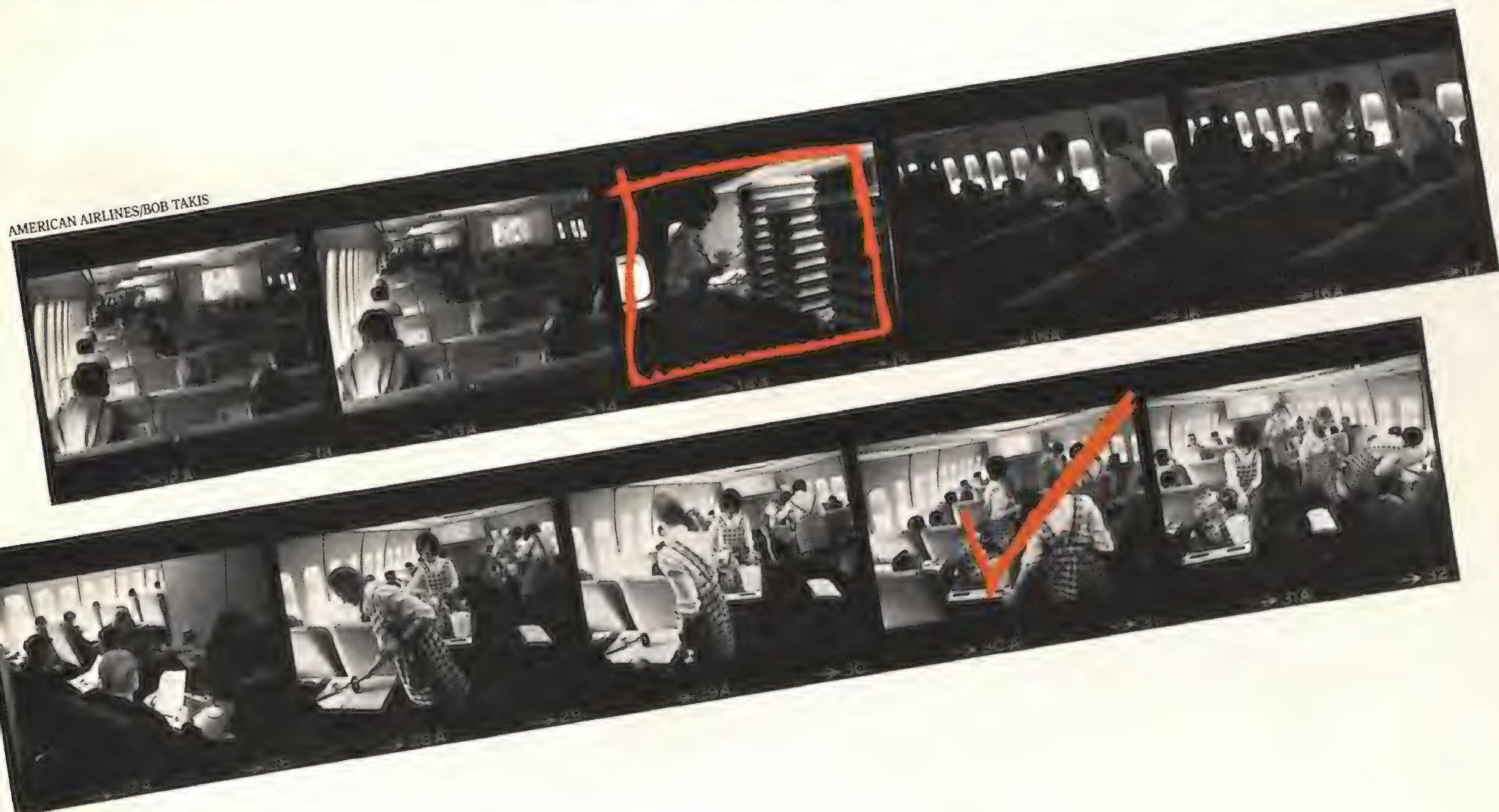
While a combo played in the background, well wishers peered through the expansive windows of the passenger lounge. Tired and anxious employees watched from overlooking offices and underlying ramps. Then the tow bar connecting pin dropped home, the diesel engine strained, the tug shuddered, and at 8:52, only seven minutes late, the giant Astroliner crept backward from the gate.

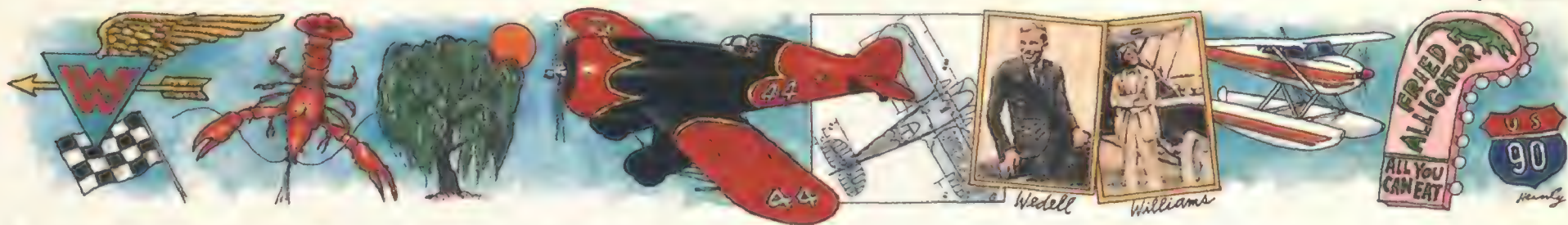
The inaugural flight was the first to offer complete meal service to a full passenger load; says Bunny Burgess, working as galley coordinator for the coach section, "A million peas; that's what I remember." Janet Luft, who had been assigned to supervise and observe, ended up pitching in, "spilling gravy all down the front of my new light blue dress." Airplane N740PA flew for over 30 days before it experienced its first delay and 38 days before it had a cancellation. And out in Los Angeles, after working 40 days straight, Joe Bourguin finally took a day off. ✈

AMERICAN AIRLINES/BOB TAKIS



Stewardesses (the term "flight attendant" had not yet come into use) posed in the Astroliner's spiral staircase—a novelty in jets—for a publicity shot American sent out with its press releases.





Louisiana Red-Hot

In the early 1930s the main draw in Patterson, Louisiana, was the grass airstrip on the Calumet plantation. In those days Lockheed Vegas carried passengers to and from the Gulf Coast town night and day, and seaplanes splashed down on the Bayou Teche. In the field's low hangars, mechanics, welders, and woodworkers turned out sleek racers as red-hot as the peppers ripening up the road in New Iberia. Wealthy lumberman and planter Harry Palmerson Williams supplied the cash. Jimmy Wedell, a shy, gangly young Texan who was blind in one eye from a motorcycle smashup, designed and flew the monoplanes that for three years swept the National Air Races.

"Hot as a .44 and twice as fast," Wedell pronounced them, and so his first aircraft were named Model 44s. Wedell's and Williams' careers were cut short by crashes: Wedell died at age 34 on a routine flight with the prospective buyer of a Gypsy Moth in the summer of 1934, and Williams died two years later on a night flight from Baton Rouge. In 1936 the petite silent-screen star Marguerite Clark Williams sold what was left of her husband's company to Eastern Air Lines.

Things are pretty quiet at Williams Field today. Huge oaks line the Old Spanish Trail that leads to the airport, and roosters wander among the remaining plantation huts across the street. During the oil boom of the 1970s, roustabouts and pilots flocked to Patterson and Morgan City to make their fortunes working on the oil rigs and flying seaplanes and helicopters on charters for the oil companies. But five years later oil prices fizzled and sugarcane and fishing again took over as the mainstays of the local economy. Now only the occasional long-legged Cessna on floats roars off the seaplane slip, bound for an oil rig.

A small brown building at the airport houses the Wedell-Williams Memorial Aviation Museum, which focuses on the racers but is also charged with documenting the state's aviation heritage. Visitors end up chatting with Tex Palmer, the compact and energetic curator who, when not flying low over the Gulf, builds shelves, cases, and

exhibits. Occasionally he is joined by foundation chairman F.C. Felterman, a tall, soft-spoken man with a melodic Cajun accent, whose father helped build Wedell-Williams aircraft.

Over a lunch of fried alligator and catfish, Palmer and Felterman explain that their funding was slashed two years ago when the state, looking to trim its budget, turned the young museum over to the local jurisdiction of St. Mary Parish. Still, there is enough money to produce a quarterly newsletter and keep Angelle Duplantis at the reception desk for the 200 visitors who stop by each month.

Of the nine racers Wedell and Williams built, only one survives, and it is ensconced at the Western Reserve Historical Society in Cleveland, Ohio. The Wedell-Williams museum does have a replica of the crimson Model 44 that crashed in the 1934 Thompson Trophy race, killing pilot Doug Davis. Its huge nine-cylinder Pratt & Whitney 985 radial engine steadily drips oil into a plate placed beneath it. Lining the walls are photos of a grinning Wedell, a sometimes somber Williams, and the racing circuit stars they built airplanes for and competed against—Davis, Jimmy Haizlip, his drop-dead gorgeous wife Mary, Jimmy Doolittle, the flamboyant Roscoe Turner. A display case houses Wedell-Williams trophies: the 1932 and 1933 Bendix, the 1933 Thompson, the 1933 Shell Speed Dash, when Wedell became the first to break 300 mph in a landplane. Other cases house air race tickets, logbooks, maintenance records, a mechanic's coat, one of Wedell's ties, his aircraft and mechanic's licenses, and some of his tools and notes (of which there are few: he is said to have designed by the "that looks about right" method). In its own case is the master log from Williams Field, which records every aircraft and pilot that landed. Mounted on pegboard are pieces of an early Model 44 that in 1982 were dredged up from the Bayou Teche, where a big pile of spare parts was unceremoniously dumped off a bridge when Eastern took over.

Other displays move beyond air racing. One of the more dramatic is an airway

beacon from the 18,000-mile network that spanned the United States in the 1930s. This one was hauled out of a swamp and installed at Williams Field as an airport beacon in 1949. Palmer's predecessor found it in a shed in 1982, refurbished it with traffic-light gears, and reclaimed one of its lenses from a woman who'd been using it as a fruit bowl. Palmer likes to dim the museum lights and turn on the huge rotating lamp, which ticks and grinds and flashes red and white.

Along with a Stearman crop duster in Delta Airlines livery, a pristine 1939 Beech Staggerwing, and a half-scale Focke-Wulf 190, there is Dwight Eisenhower's Aero Commander 680, one of a pair of the first light twin-engine aircraft authorized for presidential travel. Palmer foresees an expansion of the displays on seaplanes, helicopters, and crop dusters, all key players in the aviation history of southern Louisiana, which is more water than land.

Palmer has also started a library, the showpiece of which is a collection of *Aviation* magazines from the 1920s. "I love reading the classified," he says, paging through an issue. "Look, here's an ad from [cross-country racer] Frank Hawks, looking for a job. He's kind of a god around here. Thought he'd been born with a job."

Oil booms and airplanes have come and gone, but not all that much has changed at Williams Field and Patterson over the years. In Acadiana's *salles de danse*, fiddle and accordion players holler zydeco and Cajun tunes, the McIlhennys and Trappeys still brew their Tabasco and Louisiana Red-Hot sauces up Route 90, and in the museum, the air racers live on. "Those guys ran the biggest test laboratory of them all," Roscoe Turner once said. "They took ideas proved well on the ground and put them up in the air, where ideas count."

—Patricia Trenner

Wedell-Williams Memorial Aviation Museum of Louisiana, Highway 182 West, Patterson, LA 70392. Tel. (504) 395-7067. Open Tuesday through Saturday, 10 a.m. to 4 p.m. Admission: \$2 adults, 50¢ children.

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See NASA Tech Briefs for technical details, 1986, 1987 and 1988.

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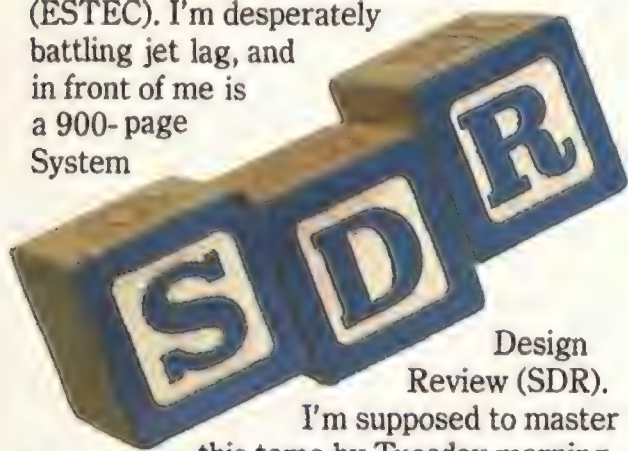
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Private Languages

It's Sunday and I'm in the Netherlands, at an office of the European Space Agency's Scientific and Technical Laboratories (ESTEC). I'm desperately battling jet lag, and in front of me is a 900-page System



Design Review (SDR).

I'm supposed to master this tome by Tuesday morning, but a paragraph on page 121 has already stopped me cold. It reads: *This budget shows a 1.6% margin for launch mass structures. OBDH, RCS, and sunshield SVM subsystems mass and PLM mass are above the specified mass.*

Last year I would have been totally stumped by this entry. But that was before I started my dictionary of acronyms. It began in 1985 with my participation in the design of the Infrared Space Observatory (ISO), which the European Space Agency (ESA) expects to launch in 1993. At each meeting of the ISO science team (IST), more acronyms crept into the discussion. Finally I couldn't keep up any longer. Neither could my European colleagues, I figured. When I showed up at the next meeting with the first edition of my dictionary, my colleagues snatched up the Xerox copies with sighs of relief.

That's the trouble with acronyms. Not only are they meaningless to the uninitiated, they don't even allow the semi-initiated to make an intelligent guess. Knowing that SCOE means Special Check Out Equipment doesn't provide any clues to the meaning of SCOM (Science Operations Manager). A dictionary like mine becomes indispensable.

Of course, acronyms aren't new. The military has been mass-producing them for years. But the space sciences seem to be working overtime to keep up. Every new aerospace project inevitably develops its own vocabulary. And with that vocabulary

come myriad acronyms that stand for spacecraft parts, test procedures, and the dozens of corporations, review boards, and laboratories associated with the project.

It's a problem of length. Writing out each word in an acronym is unwieldy (and almost impossible in drawings or tabulations). The entities could be labeled with numbers, as industrial components often are, but acronyms often serve as mnemonics, which both remind us of a meaningful name and save a mouthful of words.

It wouldn't be so bad if there were only a few such acronyms. But their proliferation is daunting. We require a vocabulary of roughly 10,000 ordinary English words in our daily conversation. When you add a thousand or so acronyms, you begin to lose your audience. A huge project on the scale of the shuttle or the space station may involve ten times the number of organizations and technical parts that a simple satellite project does. Learning all 10,000 acronyms would be like learning a new language.

College freshmen studying engineering or science often delight in the alphabet soup of acronyms. Mastering this private language gives them a sense of belonging to a professional brotherhood. But ultimately, acronyms build barriers. I've sat in meetings quite sure that half the people in the room don't know what is being discussed. When I summon up courage and propose that each acronym first be spelled out, a lot of people look relieved. This happens so often that I no longer feel foolish when I make this request.

Often a set of letters may stand for more than one concept. In my dictionary, SPC stands for both Shaker Proof Cryostat and Science Policy Committee—totally different concepts often distinguishable only by their context. What about OSR, which could mean either Optical Surface Reflector or Optical Solar Reflector? Even the context doesn't clarify which is meant.

The result is a Tower of Babel built with acronyms. Because most acronyms are discarded as soon as a project is finished, no thought is given to developing rules of construction. The project's ephemeral

lifespan doesn't permit the sorting out that normal languages undergo through the centuries. Language itself becomes an obstacle to engineering and science.

Vocabularies need to be designed that facilitate communication for large-scale projects. Otherwise these projects are bound to become managers' nightmares. The complexity of language raises the risk of mix-ups and disaster. This might partially explain why some aerospace projects are beset by the exorbitant costs and delays we read about in newspapers.

My dictionary isn't the only attempt to sort out the confusion. In fact, dictionaries of widely used space acronyms can be found on the shelves of many libraries. They contain tens, if not hundreds, of thousands of words. The 1988 edition of *Acronyms, Initialisms & Abbreviations Dictionary* boasts more than 420,000 acronyms covering most of science and technology. Yet few of these entries have any relationship to the acronyms in my own, homebuilt dictionary. The language of the ISO satellite is too specialized even for a specialized dictionary.

Meanwhile, my dictionary grows at a rate of roughly one entry each workday, or 300 per year. It now has over 600. By the time the ISO satellite is launched, we'll have exceeded 1,000 acronyms.

Looking up the acronyms in that troublesome paragraph on page 121, I find that OBDH stands for On-Board Data Handling; RCS, the Reaction Control Subsystem; SVM, the Service Module; and PLM, the Payload Module. So the paragraph really means: Design engineers are worried because the hardware is heavier than anticipated.



Unless the weight of the offending pieces is cut a few percent, the Ariane 4 rocket won't have enough power to lift the payload into orbit.

A shame they couldn't just say so.

—Martin Harwit

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Poland June 8-24.

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Amsterdam-Dutch Countryside June 14-27: See Van Gogh exhibitions.

Shadows of the Past (France) June 16-29: Chateaus, caves.

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Reviews(&Previews



***Alice and the Space Telescope* by Malcolm Longair.** The Johns Hopkins University Press, 1989. 208 pp., b&w and color photos, \$28.95 (hardbound).

***The Space Telescope: A study of NASA, science, technology, and politics* by Robert W. Smith.** Cambridge University Press, 1989. 528 pp., b&w photos, \$39.50 (hardbound).

In 1984 NASA chief James Beggs proclaimed the Hubble Space Telescope "the eighth wonder of the world." Few astronomers today would disagree that this spring's long-awaited launch of the telescope will inaugurate a revolution in our understanding of the universe (see "First Light for the Hubble," p. 52). Placed above the obscuring haze of Earth's atmosphere, the orbiting telescope is expected to provide answers to astronomy's big questions: Are there planets circling around other stars? What gives a black hole its incredible power? How fast is the universe expanding?

Malcolm Longair, Scotland's Astronomer Royal, appropriates the fantastic world of Lewis Carroll's Alice books to address the many cosmic puzzles the telescope will

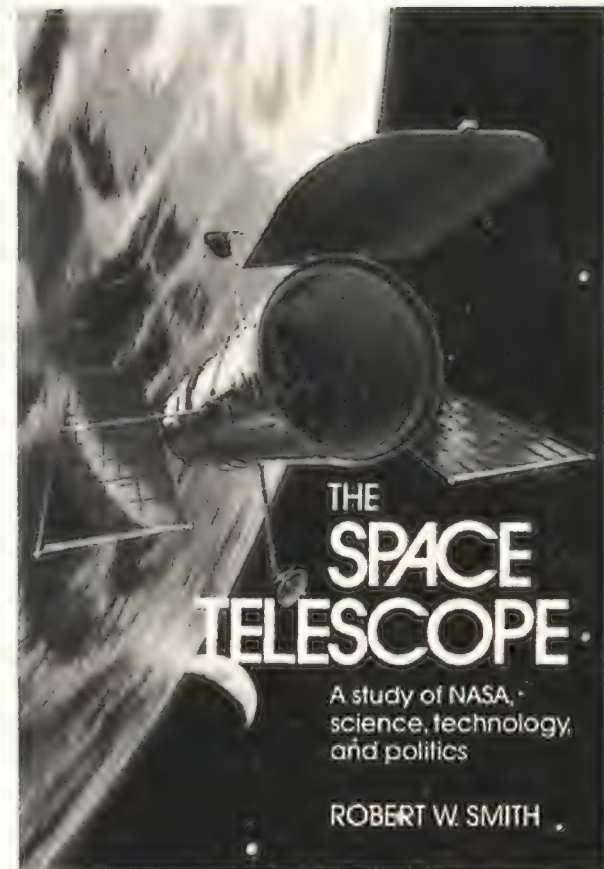
probe. Originally presented in shorter form as a lecture to the American Astronomical Society in 1984, *Alice and the Space Telescope* follows Alice (now a graduate student in astronomy) through Wonderland (the Space Telescope Science Institute in Baltimore, the Hubble's scientific headquarters) as she questions a menagerie of Wonderland characters (various astronomers) about the space telescope.

Longair has a lot of fun parodying his colleagues as they squabble over theories and research. The charm of this imaginative narrative is repeatedly diminished, however, as Alice and the astronomers digress into dissertations on current astronomical thinking. Extensive footnotes and diagrams provide the astrophysical background necessary for the lay reader, but with fully half the book devoted to this supplemental information, much of *Alice* reads like a college text, despite its playful format.

Oddly enough, something closer to Alice's looking glass world, with its upside-down logic and misleading appearances, emerges from Robert Smith's behind-the-scenes history of the space telescope program. Tracing the interplay of political, institutional, and economic forces that shaped the telescope's design, Smith describes a program that "was not devised in some ideal world, one in which the 'best' means of managing the telescope's development was the only objective."

In an ideal world, the astronomical community would have provided the impetus for building a space telescope. In the real world of the early 1970s, however, many astronomers opposed the project. NASA adopted the telescope as a firm priority in part to help justify its new space shuttle program; astronomers were wary of a big space project that might drain federal dollars from new ground-based observatories. As a result, NASA found itself in the odd position of having to actively lobby astronomers for support of an astronomical project.

In an ideal world, NASA would have made a realistic assessment of the telescope's cost. In actuality, the



telescope's budget was calculated according to what the market could bear, which at that time was as little as possible. The politically acceptable figure of \$400 million won the telescope congressional approval in 1977, but by 1980 the project was out of money and far behind schedule. The same week that the telescope's project manager realized that a 1983 launch date was "already blown," NASA officials nevertheless testified before Congress that everything was on track. (Smith estimates that by the time of the space telescope's launch, its cost will be close to \$2 billion, making it "the single most expensive scientific instrument ever built.")

As a historian, Smith is satisfied to let his extensive research speak for itself; he does not propose solutions for the problems that plagued the telescope program. But for anyone concerned about the future of space science or the manner in which their tax dollars are spent, *The Space Telescope* does raise questions about NASA's ability to manage large new-technology projects and make realistic assessments of their costs.

When the Hubble Space Telescope starts

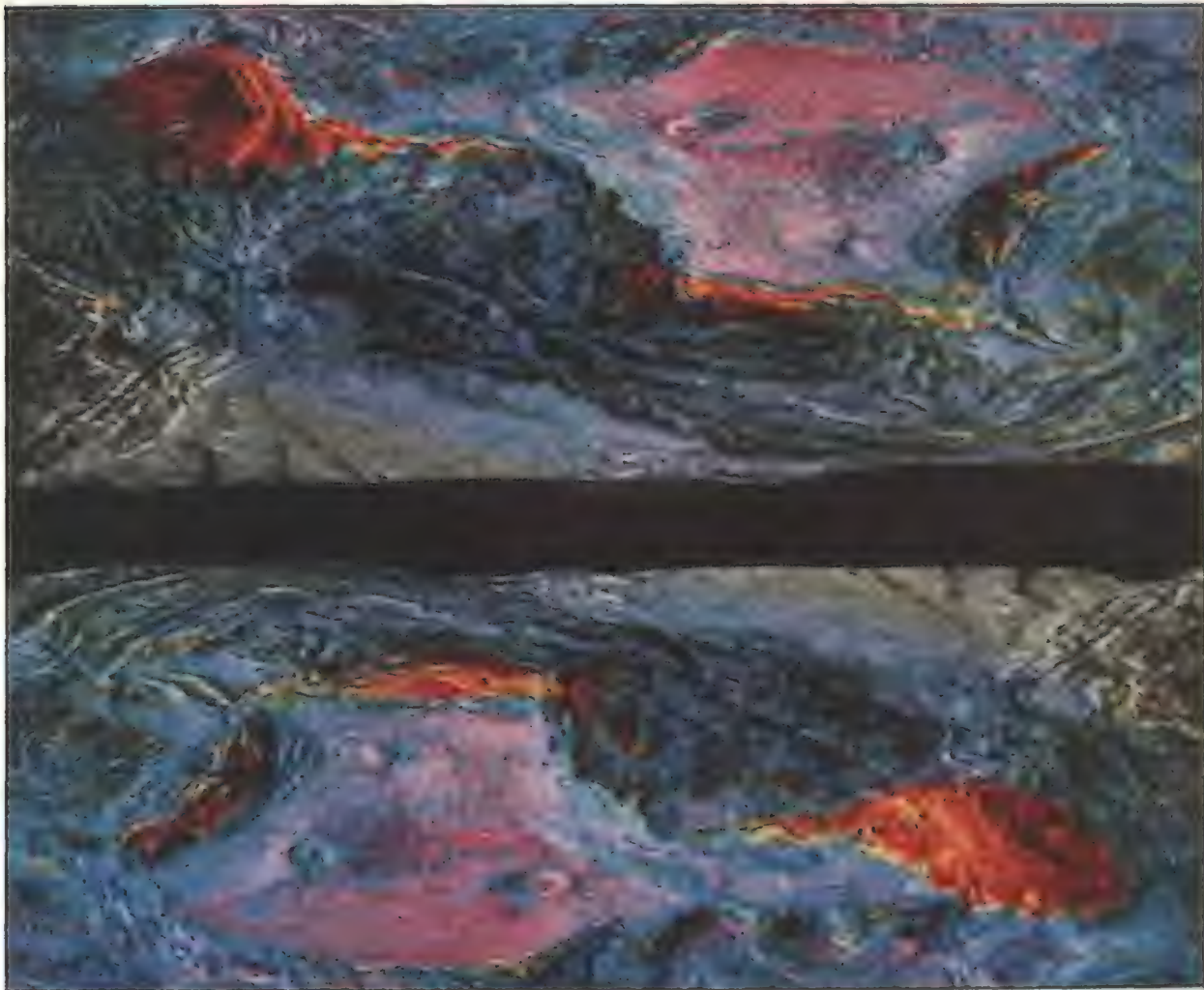
to deliver on its remarkable potential later this year and we begin to learn amazing new things about our universe, we would do well to remember that the telescope imparted its first lesson before it ever got off the ground: There has to be a better way to run a space program.

—Stephen Cole is the managing editor of *Astronomy magazine*.

Cal Rodgers and the Vin Fiz by Eileen F. Lebow. Smithsonian Institution Press, 1989. 275 pp., b&w photos. \$22.95 (hardbound).

Sure, flying across the country today can be frustrating, what with delays, cramped seating, and troublesome transfers. But Calbraith Perry Rodgers really had it rough. In 1911 he completed the first transcontinental flight, but only after 49 days and 19 crashes. By the time he reached the West Coast, all that remained of his original airplane, after numerous reconstruction jobs, were the vertical rudder, the drip pan, and a strut. Also surviving was a bottle of Vin Fiz, his airplane's namesake and Rodgers' source of financing.

Vin Fiz was a grape drink produced by the Armour meat company. According to Eileen Lebow's well-researched book, it was also a mild laxative. Rodgers didn't much care, as his drink of choice was cream. He also had a fondness for cigars, which he smoked in flight, even though the wind caused them to burn quickly. During



The Planetary System: A Slide Set and Information Book produced by the Astronomical Society of the Pacific (390 Ashton Ave., San Francisco, CA 94112; [415] 337-1100). 100 color slides and 41-page booklet, \$97.95.

With its often-reproduced images, mostly from NASA, the Astronomical Society of the Pacific's latest set of slides offers little to surprise amateur astronomers—but much to delight. Included is a haunting image of Earth from Apollo 17, vibrant views of Jupiter's volcanic satellite Io, and (above) striking false-color images of Venus. An accompanying booklet provides easy-to-understand information on each slide and includes suggested activities and a reading list, making the set ideal for use in the classroom as well as the home.



one day's flying he went through 19.

Rodgers hoped to finish the journey from Sheepshead Bay, New York, to Pasadena, California, in 30 days and thus win a \$50,000 prize offered by publishing magnate William Randolph Hearst. He didn't make it, despite the services of Charles Taylor, the Wright brothers' own mechanic, and a well-equipped train with spare parts and support services. But Rodgers did make history, and in the process introduced thousands across the country to aviation. If not for his death in an airplane crash shortly after his arrival in California, Rodgers might have made an even greater mark on aviation history.

Lebow attempts to give Rodgers his historical due, and for the most part she succeeds. This good-natured book proceeds toward its conclusion much the way Rodgers did: slowly, steadily, with plenty of stops on the way. In the process the author portrays a time when things

were—yes—simpler. Perhaps they were. In Lebow's account it was a time when laughter was always hearty, people appreciated a man who could offer "a square deal," and a woman in Oklahoma was justified in striking a "masher" who had the audacity to address her with "Hello, kid."

One drawback to the book is the author's heavy reliance on newspaper accounts of the day, never the most reliable of sources. There's no doubt that Rodgers was a gentleman, but it's hard to believe that after he climbed out of the wreckage of one of his many crashes, this one in Texas, he said, "This is just a small wreck. These wrecks are part of the game and to be expected, but of course, are unwelcome." Even Rodgers, we hope, would have given forth a heartfelt "Godfrey Daniels!"

—Tom Huntington is the managing editor of *Air & Space/Smithsonian*.

Aerospace Facts and Figures, Aerospace Industries Association (1250 Eye Street, N.W., Washington, D.C. 20005), 1989. 174 pp., \$23.50 (paperback).

Serious researchers will find this a handy reference for economic data relating to all aspects of the aerospace industry. Compiled by the Aerospace Industries Association's Economic Data Service, it's current through 1988, with projections for 1989-90.

Nightwatch: An Equinox Guide to Viewing the Universe by Terence Dickinson. Camden House, 1989. 160 pp., color photos, \$24.95 (paperback).

Start Exploring: The Night Sky by Dennis Mammana. Running Press, 1989. 94 pp., b&w photos and drawings, \$9.95 (paperback).

Observing the Constellations by John Sanford. Simon & Schuster/Fireside Books, 1990. 176 pp., color photos, \$16.95 (paperback).

There are almost as many introductory astronomy books available today as there are stars in the sky. Fortunately, three recent additions to the fold include some noteworthy efforts.

One familiar face, *Nightwatch*, is one of the best all-around general astronomy

universe by putting Earth's place in it in perspective. Simple seasonal charts with accompanying diagrams show the night sky and introduce the stars of each season for the naked-eye observer. The next section deals admirably with that age-old question, "What kind of telescope should I get?" In-depth star charts, highlighting the "deep sky" wonders of the more prominent constellations, follow.

The book's spiral-bound format makes it very easy to use at the eyepiece, and the charts are printed for use under red illumination, which preserves one's night vision. Chapters on the solar system, basic astrophotography, and equipment and other resources provide good cloudy night reading and encourage exploration.

A guide for young readers, *Start Exploring: The Night Sky* is written in an interesting and infectious style that should keep the kids away from the Teenage Mutant Ninja Turtles for a while. Its simple demonstrations of astronomical concepts provide pastimes for a rainy Saturday, and its star charts are easily translated to the real sky. Keys to pronouncing some of the more difficult names appear throughout the book, and a fine glossary and resource list round it out. This book will easily stimulate its readers and leave them with a sense that astronomy can be as much fun as a room full of dinosaurs.

Observing the Constellations shows less promise. A guide to all 88 of the sky's official star patterns, the book, while pretty, is of limited application at the telescope. Its brief introduction to the night sky completely ignores the solar system and only touches on some of the more interesting concepts behind observing the heavens. Each constellation is then detailed, in alphabetical order, with a page or two describing the more interesting double stars, star clusters, nebulae, and galaxies that lurk within its bounds. Photographs show the constellations as they might appear to the unaided eye, but (perhaps due to poor printing of my review copy) many of these images contain little more than black sky. And the star maps are somewhat cluttered, especially those for the smaller groups, making them difficult to use under red lights. One saving grace is that the charts listing noteworthy objects within each constellation are well researched and help provide an interesting telescopic tour of the entire sky.

Those who already have some knowledge of astronomy should find *Observing the Constellations* a colorful and interesting volume, but for those seeking an introduction to astronomy, the other two books are better choices. All three deal with the universe on a down-to-earth level; none

includes physics or philosophy. Rather, the books are intended for those of us who find joy, as the poet Walt Whitman wrote, in looking "up in perfect silence at the stars."

—Geoff Chester conducts stargazing expeditions for the National Air and Space Museum's Albert Einstein Planetarium.

Stealth by Doug Richardson. Orion Books, 1990. 188 pp., color photos, \$24.95 (hardbound).

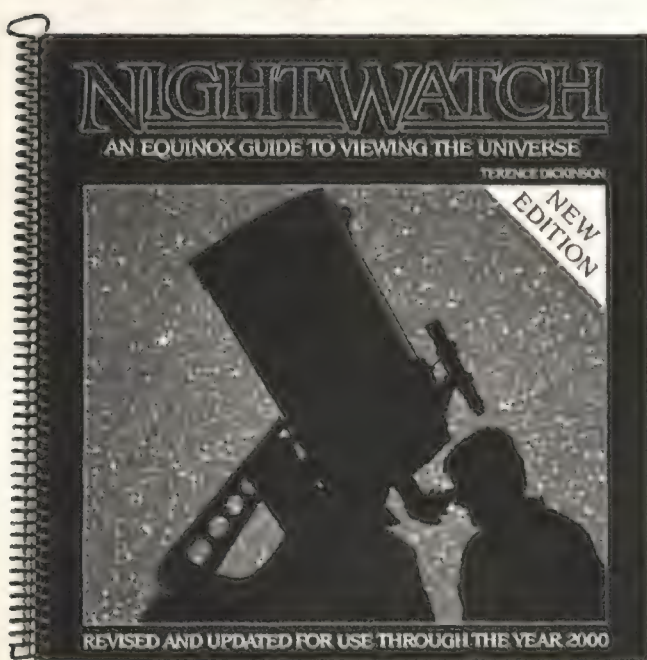
Although they've made only fleeting appearances in public, stealth aircraft have already held starring roles in several novels, including my own, and dominated the covers of aviation and military journals as well as more mainstream magazines. Part of their appeal is undoubtedly their technological wizardry; the B-2 bomber and F-117A Stealth Fighter have a James Bond-gadget air about them. Better than 007's exotic gimmicks, however, stealth aircraft are *real*, emerging from a "black world" of genuine government secrecy peopled by real spies, real heroes, and real villains. In a world jaded by the special effects of television and movies, an authentic mystery is heady stuff.

For the burgeoning subgroup of aviation enthusiasts known as "stealthies," *Stealth: Deception, Evasion, and Concealment in the Air* by military journalist Doug Richardson should prove a welcome contribution. The book is lavishly illustrated with diagrams, graphs, and a wonderful collection of color photographs. The text is easily accessible to the lay reader and is salted with references to works of literature and popular culture. Richardson also includes a lot of good gossip material about the various stealth models that emerged before any official unveiling.

The author is thorough about attributing his sources. It's important to note the frequent credit he assigns to Bill Sweetman, author of *Stealth Aircraft: Secrets of Future Airpower* and *Stealth Bomber*. Sweetman is the pioneer in comprehensive reporting about stealth technology, and anybody who follows is covering much already-trodden ground.

The chief values of Richardson's book are its wealth of detail, accessible text, and comprehensive illustration. Beyond being a "must read" for anyone interested in stealth technology, *Stealth* is a must have; its intended target is the reference shelf, where it rightfully belongs.

—Dennis Anderson, a reporter for the Associated Press, wrote the novel *Target Stealth* under the pen name Jack Merek.



books I've seen. First printed in 1983, it has been extensively updated in this latest edition. The real beauty of the book is that it relies almost exclusively on photographs taken by amateur astronomers, rather than the "pretty pictures" taken from major observatories. The text is simple to understand, and has just enough of a "gee whiz" tone to keep one's attention.

The book first introduces us to the

Credits

Freefall. Mark Shelhamer is doing post-doctoral research in ophthalmology at Johns Hopkins Hospital in Baltimore.

Never Say Fly. Edwards Park is a frequent contributor to *Air & Space/Smithsonian*.

The Flying Crowbar. Gregg Herken is the chairman of the National Air and Space Museum's space history department.

Meteorites by Mail. Dennis Stacy is a San Antonio-based science writer whose work appears regularly in *Omni*. When not pursuing known extraterrestrial artifacts, he pursues unknown ones as editor of the *MUFON UFO Journal*.

Desperately Seeking Lindy. Kenneth Koyen is a freelance writer who lives in Manhattan. He was a reporter for the old *New York Herald Tribune* and was on the staff of the *Paris Herald* when France fell during World War II.

Further reading: *Paris Herald: The Incredible Newspaper*, Al Laney, Appleton-Century, 1947.

First Light for the Hubble. George Greenstein is a professor of astronomy at Amherst College in Massachusetts. He is

the author of *Frozen Star* (Freundlich Books, 1983).

Risqué Business. A former Washington newsman, Phil Cohan is a veteran of the U.S. Foreign Service.

The Two Memphis Belles. Elaine de Man is writing a book on Margaret Polk and the *Memphis Belle*.

The Class of 1990. William Triplett is currently co-writing a book on the U.S. drug war.

The Battle Over Warbirds. Stephan Wilkinson is a frequent contributor to *Air & Space/Smithsonian*.

Countdown. John Flanagan, a consultant and writer who lives in Connecticut, says every time he thinks about N740PA, he hears the crash of dishes.

Louisiana Red-Hot. Patricia Trenner is the departments editor for *Air & Space/Smithsonian*. She has a fondness for crawfish étouffée and the Cajun two-step.

Private Languages. Martin Harwit is the director of the National Air and Space Museum.

Calendar

April 6-8
Ozark UFO Conference. Inn of the Ozarks, Eureka Springs, AR, (501) 354-2558.

April 28 & 29
Kitefest: The Spring Games. Kite-flying games and kite-making workshop. River Oaks Park, Kalamazoo, MI, (616) 383-8778.

May 3 & 4
Challenger Center Teachers Conference. Hands-on workshop and symposium on space, astronomy, and aviation with a presentation by astronaut Charles Walker. National University, San Diego, CA, (619) 238-1233.

May 4-13
Air/Space America. Aerospace trade exposition and airshow. Brown Field Airport, San Diego, CA, (619) 223-5585.

May 5
Airline Collectibles Show and Sale.

Sponsored by the Bay Area Airline Historical Society. Sheraton Airport Hotel, Burlingame, CA, (415) 574-8111.


May 10 & 11
Naval Aviation Symposium: Carrier Aviation—Past, Present, and Future. National Museum of Naval Aviation, Pensacola, FL, (904) 453-2389.

May 19 & 20
Museum of Flying Auction. Classic aircraft and aviation memorabilia will be offered to collectors. Museum of Flying, Santa Monica, CA, (213) 392-6392.

June 18-July 6
Aerospace tour of the Soviet Union. Sponsored by the Aerospace Education Association and People to People International. Participants will visit aerospace facilities in Moscow and Kiev as well as the launch site at Baikonur. For more information write to: AEA, P.O. Box 17242, Washington, DC 20041.

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630 to 1,250 MILES



Cosmos 2059
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GPS-5
12-89 CAC



GPS-6
1-90 CAC

21,750 to 22,370 MILES



Cosmos 2054
12-89 TT



PRC-26
2-90 XI



Raduga 25
12-89 TT



Syncom IV-F5
1-90 KSC

Inoperative but still in orbit

21,750 to 22,370 MILES

GMS-3

Deletions

90 to 300 MILES

Cosmos 1979
down 12-25-89

Cosmos 2048
down 10-26-89

Progress M
down 12-1-89

Cosmos 2047
down 11-21-89

LDEF (STS-11)
down 1-20-90

Launched but not in orbit

90 to 300 MILES

Cosmos 2055 USSR
photo recon

1-17-90

down 1-29-90

Progress M-2 USSR
research

12-20-89

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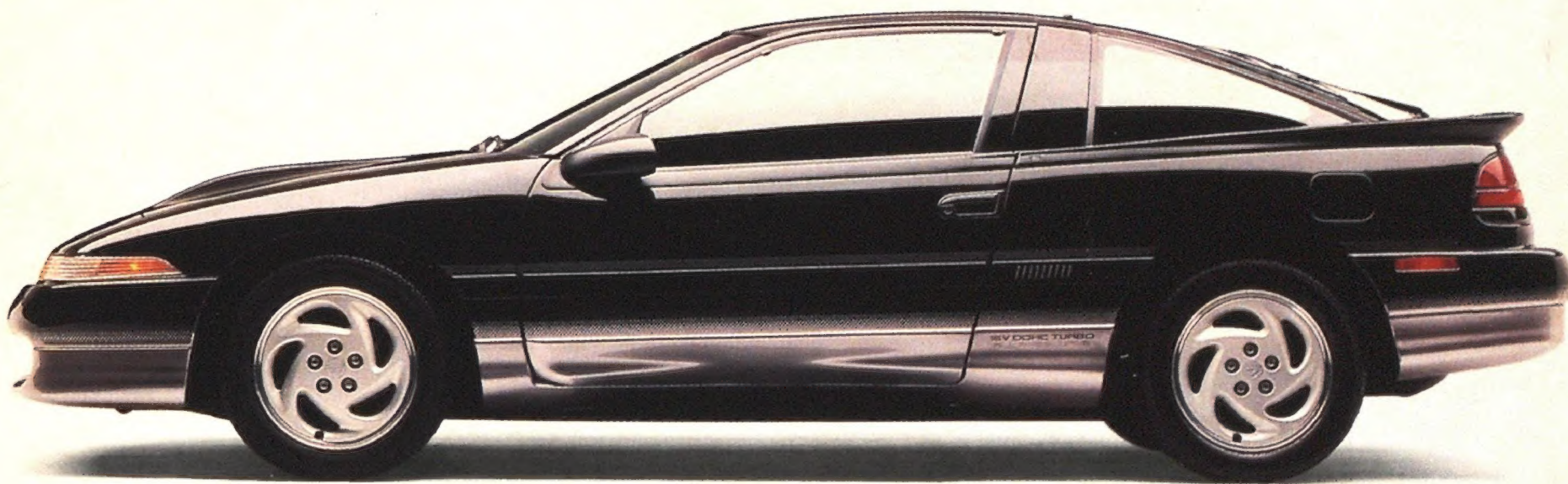
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